MEETING THE EXTENSION NEEDS OF SMALLHOLDER FARMERS: THE CLIMATE INFORMATION GAP IN THE PUBLIC AGRICULTURAL EXTENSION AND ADVISORY SERVICES IN LIMPOPO, SOUTH AFRICA

By

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DECLARATION

I, Zafezeka Zikhali hereby declare that this dissertation submitted at the University of KwaZulu-Natal has not been previously done at this University or any other institution. All the information in it is my work and what is not my work has been acknowledged.

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I agree to the submission of this dissertation

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ABSTRACT

This study examined the gap in climate information within public Agricultural Extension and Advisory Services in Limpopo. Specifically, it assessed extension officers' climate change perceptions, climate change knowledge, and their formal and informal climate education. Lastly, the study examined the extension approaches and extension officers' perceptions of overall suitability of the overall climate information disseminated to rural smallholder farmers.

The study used a semi-structured questionnaire on 90 public extension officers purposively sampled. The Limpopo Department of Agriculture and Rural Development (LDARD) employed all the officers in two districts, i.e., Mopani (Tzaneen and Maruleng Municipalities) and the Vhembe (Musina and Mutale Municipalities). The data was analysed using the IBM Statistical Package Social Science (SPSS). Content analysis was used for analysing qualitative data, such as the likert scale data, focus group discussions and key informant interviews.

The results indicated that participants were predominately male, between the age groups of 31-59 years, and possessed B. Tech/Degree qualifications. Women extension officers were slightly more educated than males. Extension officers' climate change awareness was average. Education levels had an influence on exposure to climate education, in-serve and climate change training and extension approaches used to disseminate agricultural information to client farmers. They also acknowledged that the climate change information disseminated to smallholder farmers was not suitable for their needs. The study concluded that extension officers need to keep abreast with climate change knowledge through continuous retraining. There is also a need to integrate indigenous knowledge to climate information to increase the suitability and acceptability of the information by smallholder farmers.

Keywords: Agriculture, Agricultural Extension and Advisory Services, climate change, Limpopo Department of Agriculture and Rural Development

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LIST OF ACRONYM

AEAS:	Agricultural Extension and Advisory Services
AEO:	Agricultural Extension Officer
AGRA:	Alliance for Green Revolution in Africa
AKIS:	Agricultural Knowledge/Information System
ATPS:	African Technology Policy Studies Network
CGIAR:	Consultative Group on International Agricultural Research
DAFF:	Department of Agriculture, Forestry and Fisheries
DOA:	Department of Agriculture
FAO:	Food and Agriculture Organization of the United Nations
GDP:	Gross Domestic Profit
GFRAS:	Global Forum for Rural Advisory Services
GHG:	Green House Gas
IFAD:	International Fund for Agricultural Development
IFPRI:	International Food Policy Research Institute
IKS:	Indigenous Knowledge Systems
IPCC:	International Panel for Climate Change
LDARD:	Limpopo Department of Agriculture and Rural Development
NDA:	National Department of Agriculture
SADC:	Southern African Development Community
SSA:	Sub-Saharan Africa
Stats SA:	Statistics South Africa
UNEP:	The United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change

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CHAPTER 1: INTRODUCTION

1.1 Background

Globally, reports show that about 500 million smallholder farmers live below the $2 per day poverty line (IFAD and UNEP, 2013). Worldwide, a discourse in smallholder agricultural production is observing discrepancies visible in their economic gains and food security. Approximately, 70% of smallholder farmers play a vital role as producers as world food producers (IFAD and UNEP, 2013). Yet, these farmers seem neglected as they face extreme cases of socio-economic inequalities, limited access to basic agricultural services and support. Smallholder farmers bear the consequential effects of failure to implement policies adequately. Smallholder farms, defined as being two hectares or less, represent 80% of all farms in Sub Saharan Africa (SSA), and contribute up to 90% of the production in some SSA countries (Livingston et al., 2011).

At a global scale, the agricultural sector is one of the sectors that significantly contribute towards the global economy. On a local scale, agriculture is the primary livelihood option for vulnerable and disenfranchised people residing in rural areas, often on marginalized lands (IFAD and UNEP, 2013). Smallholder farmers face extreme cases of socio-economic inequities, which institutionally block opportunities to access basic services and extension support that would otherwise holistically

improve their farming enterprises. The effects of climate change thus far has had a devastating impact on agricultural production globally and locally. Climate change effects are decreased seasonality, disrupted known weather patterns, increased duration and severity of extreme weather occurrences such as droughts, floods and heat waves (Osman-Elasha et al. 2009; Ahrens and Samson 2010).

Several policies and programs to counter this effect have been developed and rolled out in most countries. Agricultural institutions such as government agencies, the private sector and non-governmental organizations (NGOs), research institutes and education centres are the custodians of Agricultural Extension Advisory Services (AEAS), which are programs and mechanisms to build and strengthen the capabilities of smallholder farmers (Birner et al. 2009; Christoplos 2010). AS, are about facilitating outreach programs at grass root level aimed at improving smallholder farmers' situation on a global, regional and local scale, which are collectively termed as Extension and Advisory Services (AEAS) (Williams et al. 2008; Nkonya 2009; Berman et al. 2012).

This is achieved through the promotion of access to information and technologies, enhancement of agricultural skills and practices, the capacity to innovate, offering various rural development solutions through training programs and to improve management facilitated by Agricultural Extension Officers (AEOs) (Sulaiman 2003; Mbo'o-Tchouawou and Colverson 2014). AEOs play an important role in facilitating linkages with farmer-based organizations and other relevant actors such as government agencies, the private sector and NGOs, research institutes and education centre in the AEAS delivery process (Davis and Heemskerk, 2012). AEAS systems integrated climate change programs due to their huge contribution to agricultural sustainability, livelihood improvement and bettering the well-being of farmers in rural areas historically (GFRAS, 2010).

Despite these efforts smallholder farmer's adaptation, coping capacity and overall climate resilience is extremely weak continues to deteriorate (Akpalu 2013; Grist 2014). This is due to the lack of capacity of AEAS in relation to climate information. The question raised in the study is why AEAS, including AEOs, are failing to address the climate change challenges experienced by smallholder farmers especially those who reside in rural areas. The focus in on the agricultural extension agents in particular agricultural extension officers. There is a limited literature that looks at the suitability and appropriateness of the AEAS curriculum regarding climate education and

extension approaches used to disseminate climate information to smallholder farmers meet their extension needs.

1.2 Importance of the study

This study will aid in addressing some of the factors that hinder adequate knowledge transfers from the extension workers/officers that would otherwise benefit smallholder farmers. This would assist agricultural institutions to improve their curriculum and training approaches, making it relevant to the needs of the farmer. This would immensely improve efficient service delivery of agricultural institutions to communities, especially in their extension services and advisory roles. Consequently, molding resourceful extension officers well versed in current climate information, technologies and farmer preferences. Extension officers at the ground level can apply innovative solutions in collaboration with smallholder farmers. This will invigorate the dependability of AEAS in promoting socio-economic development in rural areas.

1.3 Research Problem

The South African agricultural sector is performing below average compromising the country's Gross Domestic Product (IFPRI 2002; Hellin 2012). At household level, food insecurity is worsening and agricultural involvement is decreasing due to decreasing yields and worsened hardships in agriculture posed by climate change effects. Accessibility of extension services, accurate information on climate information and adequate support on climate change, to enhance climate adaptability and to strengthen resilience of farmers seems to be a barrier to obtaining significant livelihood and prosperity of smallholders.

1.4 Main Objective

The main objective of this study was to investigate the climate change information offered by Agricultural Extension and Advisory Services and the extent of their failure to meet the extension needs of smallholder farmers, in the face of climate change. Determine the climate change awareness of extension officers and their level of understanding of the climate change.

1.5 Specific objectives

(i) Determine the climate change awareness of extension officers and their level of understanding of the climate change.

(ii) To assess the inclusion of the climate change concept in the curriculum of agricultural extension officers.

(iii) Evaluate the perceptions of agricultural extension advisory service personal services regarding the suitability of the climate information they disseminate to smallholder farmers

1.6 Study Limitation

One of the drawbacks in this study was the limited and outdated literature linked to climate change and the role of extension services, particularly from the Sub-Saharan region in particular the South African perspective. Secondly, the willingness of participants to provide honest accounts of their sector and giving genuine responses.

1.7 Definition of Terms

Agricultural Extension Advisory Services: Systems that facilitate the access of farmers, their organizations and other market actors to knowledge, information and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions; and assist them to develop their own technical, organizational and management skills and practices" (Christoplos, 2010).

Climate Change: Change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and, which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 1992)

Climate variability: Climate is the aggregate of weather conditions averaged over a sufficiently long time. However, as the weather varies from day to day climate conditions fluctuate intra-seasonally and inter-annually (Gaan, 2008).

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The role of agricultural institutions is significant, as they are responsible for providing Agricultural Extension and Advisory Services (AEAS), to rural subsistence and smallholder farmers. In developing countries, AEAS have been a vehicle for rural economic development, providing rural farmers with the opportunities and assistance that have resulted in improved agricultural yields, translating to enhanced livelihoods and household food security for smallholder farmers.

Despite the strides made by government-led AEAS in Africa, especially Sub-Saharan Africa, institutional failures undermine extension service delivery. This has contributed to under-resourced and demotivated extension officers on the field. Climate change introduces an array of new challenges that are always geographically and context specific, intensely diversifying the needs of smallholder farmers. Due to the long–term working relationships between extension officers and smallholder farmers, AEAS have the potential to build the climate resilience of rural agrarian communities (Davis et al., 2014). The main purpose of this literature review is to understand government-led AEAS in relation to climate change, within the South African context. The literature also aims to gain insight on extension services, focusing specifically on approaches and trends that shape AEAS and their impacts on the needs of smallholder farmers in South Africa.

2.2 Is it global warming or climate change?

"*Some people call it global warming; some people call it climate change. What is the difference?"-Frank Luntz*."

The academic circles or popular media use the terms global warming and climate change interchangeably. Although these terms are synonymous, they define two different scientific processes that are interlinked. In truth, these terms, though similar scientifically describe two different processes that are interlinked. More accurately, global warming refers to the increase in the earth's average temperatures. This is due to excess greenhouse gasses such as methane, chlorofluorocarbons, and carbon dioxides (Gaan, 2008). These greenhouse gasses are the earth's blanket that traps and absorbs some of the infrared radiation into the earth's atmosphere, then emit the rest back into space (Farmer and Cook, 2013). This process occurs naturally and is paramount to the survival of all living species on earth. The main function of this process is to keep the planet's

temperature at an optimum temperature to maintain life, without it there would be no life on earth (Forget, 2013)

Climate change refers to an increase or decrease in the average global temperature, extending over a long period of time (Hussen, 2004). It is also important to note that "long period of time" refers to a geological time frame, that is gradual and is measured over hundreds to millions of years (Grandstien et al., 2012). Global warming gradually causes climate change, which is an entirely natural and fundamental process (Mathez, 2013). The earth has gone through natural phases of cooling and warming without human influence, for millions of years (van Kootsen, 2013). While climate change is a worrisome global phenomenon, scientists, academics, and activists are most concerned about is anthropogenic climate change. Anthropogenic climate change can be defined as the additional production of greenhouse gases (GHG's: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20), emitted as a result of human activities that ranges from burning fossil fuels, industrialization and Agriculture (von Storch and Stehr 2006; Mann 2008; Bracmort 2010).

According to Thornton and Cramer (2012), statistics from the figures from the Consultative Group on International Agricultural Research (CGAIR) indicate that agricultural production is responsible for emitting 2,000 megatons of carbon dioxide equivalent a year, which is up to 86% of all food-related anthropogenic greenhouse-gas emissions. The Intergovernmental Panel on Climate Change (IPCC) (2007) reported that global average temperatures have increased inordinately since the mid- 20 century due to the observed (Maharjan and Joshi, 2013). The Fifth Assessment Report of the Intergovernmental Panel on Climate Change stressed that humans' contribution to climate change is clear (IPCC, 2014).

The climate change phenomenon natural and anthropogenic is neither irreversible nor repairable. This affects and disrupts the mechanisms responsible for synoptic weather patterns on a global, regional and local scale. Responsible for 'unfavourable' climatic conditions that have negative implications for all forms of agricultural production (Feller and Vaseva 2014; Mittal et al. 2014). History shows that climate change causes mass extinctions, human displacement and vulnerability. To date, approximately 270 million individuals across the globe face are vulnerable to climate change the increased occurrence and severity of natural disasters (McMichael and Woodruff. 2005).

2.3 Climate Vulnerability

IPCC (2014:5) defined the term vulnerability as "the propensity or predisposition to be adversely affected". Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm, lack of capacity to cope and adapt. In the context of climate change, Jones et al. (2010:3) state that vulnerability points out an individual's capability to resist, cope with, and recover from the impact of climatic shocks and stress. The term vulnerability is continual, but differs during certain seasons or even at different periods of individuals' lives. Vulnerability also differs within groups across communities, which is directly linked to an individuals or household livelihood activities (O'Brien and Leichenko, 2007; Antwi-Agyei et al., 2013).

The agricultural sector is the most vulnerable to climate change as it affects optimum condition necessary for abundant crop and livestock production (De Salovo et al., 2013; Gbetibouo et al., 2010). Climate change has negative impacts on the agriculture areas that provide and support the socio-economic activities of individuals, particularly in developing nation and regions of the world (Enete and Amusa, 2010). According to various sources of literature, the majority of climate vulnerable individuals reside within Sub-Saharan Africa; South, East and South-East Asia; tropical areas of Latin America; and some Pacific island nations (UNFFCC, 2007; FAO, 2015). Furthermore, these people rely solely on agriculture as a livelihood option. They experience the direct impacts of climate change that include erratic rainfall, low productivity, increases in pest, disease and droughts (Brown et al., 2012)

Other studies and literature on climate change and vulnerability indicate that the marginalized suffer the impacts of changing environmental conditions (Ribot et al., 1996; Adger et al. 2011; Smit and Pilifosova, 2001; Downing and Patwardhan, 2003; Willroth et al., 2012). Marginalized people subjugated institutionally and economically, are often the causalities who suffer loss, physical injury or death when extreme weather occurrences happen. Porter et al. (2014) state that overall smallholder agriculture employs a multitude of unskilled workers who support their families, earning below the stipulated $1.25 per day poverty line. They have reduced capability of recovering after natural disasters strike due to their lack of assets to engage in alternative economic activities (IPCC, 2014). Subsequently, disadvantaged smallholder farming communities are more likely to experience heightened climate vulnerability due to the reduction of natural resources (availability of clean water) as well as food security, which indirectly (outbreak of diseases) and

directly impede on their livelihood activities (OECD, 2013). This category of farmers is directly dependent on climate-sensitive resources to gain their livelihoods such as agriculture, livestock husbandry and fisheries, in most cases agriculture is the only means of economic activity (Enete and Amusa 2010; IFAD 2009).

2.3.1 Climate vulnerability in Africa

Though contributing less than a tenth of global of GHG emission, the African continent is extremely vulnerable to climate change (Hulme 2009; Urama and Ozor 2010; Lomball et al. 2011; Swain et al. 2011; UNEP 2014). IPCC Fifth Assessment Report (2014), states that average temperatures in Africa have risen by 1°C in many regions on the continent. Temperature projections show a 2°C increase by the year 2100. This is problematic as many regions on the continent already experiences intra and inter climate variability characterized by drought or flooding, recurrent droughts and floods affecting both crops and livestock production and 98% of the agricultural sector relies on rain-fed crop (Niang et al. 2014; Grist 2014). According to Africa's Adaptation Gap Technical Report (UNEP, 2014), agriculture particularly crop production is expected to be reduced across much of the continent as optimum growing temperatures are surpassed and growing seasons shortened. The areas that are appropriate for any given crop will decrease as local climates change. Warming on the planet is projected to surpass 3°C globally; virtually all of the present maize, millet, and sorghum cropping areas across Africa could become unable to grow these crops (Freitas et al. 2014; UNEP 2014).

Due to climate vulnerability, African smallholder farmers face triple jeopardy. Firstly, the majority of smallholder farming communities are located in rural areas that are either arid or semi-arid environments, making them more climate sensitive than other regions in the world (Turpie and Visser, 2013). Literature on rural livelihoods identifies seasonal climate variations associated with rainfall; primarily its periodicity and quantity is the greatest aggravation to rural farming households (Osbahr et al., 2010; Devereux et al., 2013; Kangalawe and Lyimo, 2013; Misra 2014). Secondly, due to prevailing intra and inter climate variability coupled with the use of low technology approaches such as inter cropping and conducting their agricultural activities marginal land, locally produced food in not always regularly available (Kang et al. 2009; Enete and Amusa 2010). Lastly, the lack of food security is double when extreme weather events occur as these increases the number of months where food is not available. According to Harvey et al. (2014),

rural farming households in Madagascar reported that on average they experienced 3.8 months of food insecurity after cyclones, 3.2 months following droughts and 3.4 months after experiencing floods.

Seasonal food insecurity increases the likelihood of food and financial shortages, during extreme climatic condition suggest that farmers on in Africa a chronically food insecure (Haile 2005; Kadi et al. 2011). As farmers depend almost entirely on agriculture for employment and income, they often cannot find the money needed to purchase food that diversifies their diets, even when available on the market (Harvey et al., 2014). The lack of adequate food has a substantial livelihood implication, including increased rates of malnutrition and child mortality. The sluggish pace of poverty reduction on the continent hinders the ability of smallholder farmers to combat climate vulnerability. This also highlights to some extent the failure of the Millennium Development Goals over the past 15 years to ensure economic growth at all economic levels of society (Chandy et al., 2013).

2.3.2 Climate vulnerability in the SADC Region

The Southern African Development Community (SADC) sub-region of Sub-Saharan Africa is one of the regions most affected and climate vulnerable in the world (Niang et al. 2014; Barnard 2014). According to the Alliance of Green Revolution in Africa (AGRA) (2014), in 2014 the African continent experienced one of the most scorching years ever, second to temperatures of 2010. Temperatures in SADC countries such as Zimbabwe, Mozambique, and Angola were extremely high, in South Africa temperatures reached a record high of 47.3°C on March 4 – the hottest March temperature ever measured in Africa (AGRA, 2014). The SADC region's agricultural sector is extremely vulnerable to climate change due to its high dependency on rain-fed agriculture. The region's irrigated cropland is only 6%, and is situated in arid to semi-arid environment systems, the low levels of mechanization and willingness to adopt new technologies by smallholder-subsistence farmers due to poverty contributes to poor agricultural productivity (AGRA, 2014)

The SSA and the SADC region are familiar with drought conditions attributed to seasonal climate variability. However, prolonged drought conditions have been intensified by global temperature increases and the by the El-Niño Oscillations (ENSO) (Ward et al., 2014). Historically, the by the naturally occurring phenomenon affects the region and further affects Sea Surfaces Temperature and subsequently affects weather and climatic patterns. Within the SADC region, ENSO lasted up

to 8-12 months per phase (El-Niño, La- Niño, and Neutral processes). The arrival of ENSO was officially declared announced on 15 March 2015 (FAO/GEIWS, 2015) Traditionally, El Niño has occurred towards the end of the main cropping season during the dry season with no significant variation from normal weather patterns has been observed during past events (FAO/GEIWS, 2015). However, below normal conditions were predicted, which resulted in below average rainfall coinciding with the main crop seasons from October/November (planting) to March (harvesting) (Kisaka et al. 2014; Rojas et al. 2014). Currently, El Niño is resulting in stressed vegetation conditions, limiting crop development and adversely affecting potential yields. However, to date, no precise quantitative correlation exists between the occurrence of El Niño and its impact on agricultural production (FAO/GEIWS, 2015). Climate Change prediction models, hypotheses that climate change will increase the frequency of this phenomenon, prolonging drought conditions, decreasing recover time both for the environmental systems and the people who use them (Latif and Keenlyside, 2009).

Southern African countries, primarily South Africa, have experienced below average rainfall patterns, which to date have developed into a full-blown drought. According to the South African-Food and Nutrition working group for the Southern Africa region (2015), climate data suggest that South Africa is currently experiencing the worst drought and water shortage since 1992. The most devastated areas in South Africa are KwaZulu-Natal, the Free State, North West, the Northern Province and Limpopo Agricultural production, especially main staple crops such as maize and sorghum has fallen to an all-time low in 8years. This has consequently led to increases in food prices and even higher increases of over 27% in staple crops, especially white maize (Yende, 2015)

The drought has devastated provinces like Limpopo whose Gross Domestic Product (GDP) and agricultural sector is driven by an estimated 273 000 smallholder farmers and about 5 000 commercial farmers (Oni et al., 2012). The smallholder farmers in Limpopo face similar challenges like their counterparts in other parts of Africa. Such as institution failure and lack of support, high population growth, poor development, poverty and lack of technology. That has collectively contributed to the high climate vulnerability of smallholder farmers on the continent. Addressing these challenges would aid in facilitating climate resilience through sustainable coping and adaptation strategies amongst smallholder farmers.

2.4 The Needs of Smallholder farmers: Resilience, Adaptation and Mitigation

Climate resilience

As with climate change, the concept of climate resilience is a contemporary one. There has been a lot of debate among academics, scientists, humanitarians and development agencies in a single definition. This has caused a multiple definition to arise, reflecting different perspectives. For example, the IPCC (2014) defines "resilience as the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions". Pelling (2010) defines the concept from a human development perspective stating that climate resilience is the capacity of socio-ecological systems to be able to absorb stressors whilst maintaining function in the face of the external stressors imposed upon it by climate change impacts. Folk (2006) and Nelson et al. (2007), add that socio-ecological needs to be able to adapt, reorganize and evolve into more desirable configurations that not only leave the system better prepared for future climate change impacts but also improve the sustainability of the system. Using the concept of resilience to combat is a logical approach as it gives an opportunity to classify and inspect factors that hinder rural farmers from overcoming or being susceptible to climate vulnerability. Speranza (2010), states that climate resilience offers an analytical lens to address adaptive capacity and underlying no climatic causes of vulnerability. Smallholder farmers' needs constantly revolve around managing climate risks; they need holistic and appropriate adaptation strategies to protect their livelihoods and food security.

Adaptation

Lamboll et al. (2011) categorized the responses to climate change into two core groups. Firstly, mitigation that can be understood as addressing the causes of climate change, e.g. the banning and discontinuing of CFC hairspray and refrigerators, in the late 70's was a mitigation strategy aimed at decreasing the amount of GHG emission caused by the use of these products. Secondly, adaptation is addressing the effects of climate change (Lamboll et al., 2011). An example of adaptation would be the prescription of climate resilient or genetically modified seeds to farmers to increase agricultural production and food security, which has decreased due to climate change. Additionally, Tubiello (2012), states that the benefits of adoption choices are realised almost

instantly, but only under moderate climate change, maybe up until the Mid-century. By contrast, mitigation benefits occur decades later, becoming relevant towards the end of the century.

Adaptations are adjustments that moderate harm or exploit beneficial opportunities in response to actual or expected climatic stimuli or their effects are therefore imperative (IPCC, 2007). Many studies argue that adaptation be defined strictly along the lines of deliberate changes made in response to climate change (Agrawala and Fankhauser, 2008). Therefore, adaptation is a group of processes and actions that help a system absorb the changes that have already occurred, or predicted to occur in the future (Adger et al., 2011). Smallholder farmers around the world have traditionally relied on Indigenous Knowledge Systems (IKS) in agriculture as a means of adaptation and building their climate resilience (Codjoe et al. 2013; Ajani et al. 2013). The system is entirely embedded in cultural practices and beliefs, in many rural communities, indigenous knowledge is considered the basis for local level community decision-making (Sewdass, 2014). The experiences of past generations influenced this type of knowledge system not based on scientific information (Daskon, 2010). IKS developed through experimentation, trial and error based on the various adjustments to agricultural methods and practices in a number of environmental conditions (Fabiyi and Oloukoi, 2013).

However, adaptation strategies based on indigenous knowledge alone have become increasingly insufficiently in mitigating climate change impacts. Globally, stakeholders in the public and private sector have taken the responsibility of developing adoption plans and policies that address climate change in rural communities. In Africa, it is chiefly the national government that the initiates governance system geared at adaptation, i.e. disaster risk management, adjustments linked to infrastructure and technology, livelihood diversification and ecosystem-based approaches to increase climate resilience (IPCC, 2014).

Grits (2014), states that one of the shortfalls of government-led adoption approaches are that they are too engrossed in short-term agricultural production and poverty reduction. Rather than redressing long term institutional, economic and political challenges that prevent holistic and long-term climate adaptation. For example, in South Africa, the National Department of Agriculture (NDA) is more likely provide access to agricultural inputs rural smallholder farms, as a quick and easy solution to increase national food security. Avoiding pertinent issues such as, land redistribution, inequitable land holding issues, gender equality, more affordable agricultural inputs

and effective extension services, for rural farmers. Adaptation is an important aspect of climate resilience as it limits the possible of risks of inevitable climate change today and in the future.

It is undeniable that climate change introduces new uncertainties that further modifying known risks and vulnerabilities, which shape the types of climate resilience strategies and adaptation methods, smallholder farmers employ. This illustrates the importance of gaining accurate climate information to ensure the best coping strategies. However, misleading information and assumption on climate change is a huge contributor, to farmers adopting unsuitable adaptation strategies. Speranza (2010), states that sometimes policies, plans and agricultural practices prescribed to rural farmers that beneficial in the short term, but increase both climate and non-climate vulnerability in the long term, decreasing climate resilience. It is undeniable that institutional failure and lack of financing is responsible for the overall low adoption rate amongst farmers in SSA, SADC and the rest of Africa. However, institutional failure is only one aspect of the problem, inaccurate climate information gained from media, personal observation and shaped by social interactions and cultural belief lead to climate scepticism, also contributing mal-adaptation (Wilson 2002; Ashe 2013; Christian 2014).

Coping Strategies

People develop coping strategies to deal with climate change as with other shocks or stresses based on the adaptation strategies they have adopted. The more effective the coping strategies are in absorbing climatic shocks and stressors, increasing the resilience capacity of their livelihoods (Berman et al., 2012). Farmers coping strategies are not only limited to adjusting agricultural practices. They also include building social networks, use of traditional forecasting to get ready climatic changes and other innovative and resourceful ways of protecting their assets. For example, in Asia during times of floods farmers float their seedbeds (Thornton, 2011). Resource-poor smallholder farmers develop coping strategies that are naturally more restricted climate change as a stressor on their livelihoods, due to socio-economic inequity (Codjoes et al., 2013). This forces individuals to employ in unsustainable coping strategies that put further strain on the households' ability to rebound after a climatic stressor, such as taking out a loan, decreasing food portions and migration to larger towns to participate in unskilled labour.

Another barrier to farmers adopting sustainable coping strategies is climate information that conflicts with farmers' indigenous belief and value systems, which leads to suspicion or sceptics

about the occurrence climate change. Kahan et al. (2007), uses a theory termed "identity-protective cognition "explains why individuals dismiss or adopt evidence, according to how it fits in with common value, they have with others and their own cultural norms. This suggests that evidence on climate change is either accepted or rejected based on whether the information is affirmed by farmers 'cultural values and beliefs (Cohen et al. 2007; Kahan et al. 2011). Donnelly et al. (2009), adds farmers adopt adaptation measures and develop coping strategies will not interfere with their current farming practices, or require them to leave their land, enterprise, and community (Donnelly et al. 2009). To some extent, this explains the wide gap in adaptation to climate change in Africa. This is the reason various research, government, and developmental agencies from public and private sector collectively known as Agricultural institutions have banded together to find solutions to address the needs of smallholder farmers through Agricultural Extension and Advisory Services (AEAS).

2.5 What are Agricultural Extension and Advisory Services?

There is no universal definition of Agricultural Extension and Advisory Services (AEAS). Different organizations, literature, and academics define concept according to their specific circumstance and context. Jones and Garforth (1997), explains at the term 'extension' are derived from educational development that notions to "extending" relevant and useful information to the adult population at large.

In the context of rural development, AEAS are "mechanisms and systems that are designed to build the capacities and strengths of rural farmers and other affected stakeholders" (Mbo'o-Tchouawou and Colverson, 2014:2). The primary function of AEAS is the application scientific based knowledge and technologies, which aims to improve agriculture through non-formal farmer education (Abdu-Raheem and Worth 2011; Zwane 2012). Providing access to information and technologies improves rural agricultural practices and skills of rural farmers, in order to address various rural development challenges (Birner et al. 2009; Christoplos 2010; Zakaria 2013).

Three key stakeholders are vital in supplying extension services. Firstly, there are Non-profit and non-governmental organizations that include international research institutions and centres, universities and agricultural extension training (AET) institutions. They are responsible for studying and assimilating data concerning agricultural challenges affecting rural agriculture (Nkonya, 2009). Secondly, there is the public sector controlled by the national government. Public

extension represented by national, regional and local departments and ministries of agriculture (Nkonya, 2009). Their responsibility is to disseminate and diffuse scientific information received from private actors to rural farmers. Then there are stakeholders from the public sector, which includes agricultural input distributors, manufacturers, agribusiness and private production firms (Kazbekov and Qureshi 2011; Preissing et al. 2013). These actors interact to provide the flow of information and inform planning, implementing, monitoring various policies, programs, and initiative to affect rural agricultural development.

The field of AEAS has evolved over the years, incorporating a wide range of learning approaches, theories, and activities developed to improve the rural livelihoods through crop and livestock production. The system has gradually accumulated other functions such as transfer of technology, increasing food security, human development, linking farmers to markets and other parties in the agricultural value chain and institutionalization of farmers into farmer groups or business entities (NDA 2005; Davis et al 2014; Bingen and Simpson2015). In African countries, AEAS aims to eradicate rural poverty and meet food security targets at the national level (Jones and Garforth 1997; Anandajayasekeram et al. 2008). Extension services in Africa have traditionally focused on increasing production, improving yields and transfer of technology, even to date (Davis, 2009). Literature depicts public extension on the continent to have challenges linked to poor funding, such as weak human capacity, limited access to extension services by women, low morale of extension officers and the growing uncertainty of AEAS role in building the climate resilience of rural communities (Qamar 2005; Oladele 2009; Nkonya 2009).

The World Bank and IFRI (2010), state that Extension and advisory services today are viewed from a broad systems perspective, that focus on the roles and capacities needed at an individual, organizational, and system levels to address current challenges. However, there is a lack of pre-service and in-service training of agricultural extension and advisory agents especially, in developing countries (Worth, undated). Especially, regarding climate change education attributed to the lack of mainstreaming and integration of climate education in the curricula of universities and AET institutions (Temu et al. 2003; Chakeredza et al. 2008; Chakeredza et al. 2009; UNESCO 2015). Especially, regarding climate change education attributed to the lack of mainstreaming and integration of climate education in the curricula of universities and AET institutions (Lotz–Sisitka et al., 2015). In an ideal world, the outcomes of pre-service and in-service training would produce

extension officers with both formal and informal skills relevant for building climate-resilient extension services for farmers (Mutimba, 2014). The effectiveness of extension and advisory services is highly dependent on the ability of competent extension personnel. The whole extension process is dependent on their capacity to transfer information from extension organizations to their clients (Ali et al., 2012).

Davis et al. (2014), states that if the challenges in AEAS can be overcome these services could be the answer to improving farmers' resilience to climatic shocks and risks. Literature from Modernizing Extension Advisory Services (MEAS) identified gaps in extension on climate change. Public extension services are shifting away from services solely focused increasing agricultural production. There is more focus on sustainable agricultural and land management practices to ensure long climate resilience and food security

2.6 Gender Dynamics in Agricultural Extension Advisory Services (AEAS)

Internationally, women are a symbol of substances, also an underutilized force for accelerating sustainable development (Singh et al., 2013a). Studies also show that climate variability/ change affects women and girls, differently to men and boys (Bugura 2010; Dankelman 2010; Teklewold 2013) due to the social power and freedoms men have over women. For example, men can move away from drought-stricken areas, as they are traditionally more detached from family responsibility compared to women. The literature confirms that women and men are equally efficient in agriculture (Doss 2011; Teklewold 2013; Okali and Naess 2013). They produce the equal amounts of yields to men if not more. Closing the gender gap in agriculture would generate significant gains for the agriculture sector and for society. If women had the same access to productive resources as males, female farmers could increase yields on their farms by 20–30 percent if not surpassing that of men. Raising agricultural access to outputs reduce the numbers of hungry people by 12-17% partially eradicating hunger in developing countries (Manfre et al., 2013).

Women are more likely to impart knowledge and use their income to improve the well-being of their families and communities at large (Sheheli, 2012). Even in their state of disenfranchisement, women control additional income, they spend more money on food, health, clothing and education for their children than men do (Nellemann, 2011). This has positive implications for the immediate and long-term well-being, human capital development and economic growth through improved

health, nutrition and educational outcomes (Rubin et al., 2009). In Africa, there has been a substantial increase in the female share of the agricultural labour force in recent decades. In addition, there has been an increasing trend of female-headed households due conflict, HIV/AIDS and male out-migration (Seebens, 2010). In South Africa, there are 40% cases of male-headed households compared to 60% of female-headed households. The male head himself is not active in agriculture; it is the women's preoccupation (Stats SA, 2010)

Women are key players in maintaining household food security and female farmers are just as efficient as their counterparts are. However, despite their role they have lower access to inputs and most importantly services such as extension advice. Ethiopian women access to extension services is 20% versus men's at 27%, while there is a large disparity of 19% of women versus 81% for men receiving visits by extension officers (Kiptot and Franzel 2012; Ragasa et al. 2014). Notions about who is the farmer can hinder women at an institutional level. Culturally, gender roles denote all aspects of farming and who controls production resources and marketing. These definitions constrain and marginalize women (Boudet et al., 2013). There is also a narrow definition of women's roles in agriculture. It often leaves out a range of predominantly women's activities including contributions to agricultural production (Quisumbing et al., 2014). In order to address these constraints the Agricultural Knowledge/Information System (AKIS) approach introduced by the World Bank in 2000, to some extent, has successfully addressed gender inequality reflected in research and extension service policies (Hart and Aliber, 2012). An example, of this constraint that prevented women's ability to access AEAS is that many of the services require/expect payment for information in African some countries. Yet, many women in rural areas have little to no access or control of financial assets (Doss 2011; Jost et al. 2015). This continues to be a major challenge for female smallholder women in accessing extension services and support (GRFAS, 2012). In addition, the types of climate adaptation and technologies offered by AEAS in the past, have not been gender sensitive towards women, consequently female farmers have not applied them to their farming practices weakening their climate resilience (Skinner, 2011).

Women's inclusion within the agricultural research community show similar trends, most scientists and extension agents in the field are men. In Ghana, women accounted for less than 20 percent of the student population in agricultural science, Senegal ranks in second lowest position out of 12 countries in a recent global review of women's participation in higher education in the

agricultural sciences (Beintema and Di Marcantoni 2010; Manfre and Rubin 2012). The profile of South African extension demonstrates a similar trend, black African female farmers dominated the agricultural sector in the country, yet the majority of extension workers are men (Hart and Aliber, 2012). Increasing the number of women extension officers would greatly improve the service delivery, as female farmers may feel more comfortable with fellow female extension offices, especially when dealing with messages that involve decision-making at the family level (Mbugua, 2014). Engendering women in agricultural research and extension systems will be beneficial in developing gender inclusive climate resilience best-fit agricultural practices, as the majority of smallholder farmers are women.

2.7 Agricultural Extension and Advisory Services Models and approaches

This section gives only a brief synopsis of in extension services, highlighting their advantages and disadvantages. The changing nature of agricultural development goals held in the government and the pressure to meet these goals influence the transition of extension approaches (Swanson, 2008). The main objective of national agricultural goals is to improve national food security in both rural and urban areas (NDA, 2005). Also improving the natural resource management, especially amongst resource-poor farmers have become a high priority (DOA 2001; Rivera and Qamar 2003; Anandajayasekeram et al. 2008).

Swanson and Rajalahi (2010) identified four paradigm AEAS. These are:

1. Technological transfer that uses persuasive methods for telling farmers, which varieties and production practices they should use to increase their agricultural productivity and thereby maintain
2. Advisory Services uses public extension officers and private-sector organization, in responding to specific farmer inquiries about particular production problems
3. Non-formula Education for rural people and farmers shifting more toward training farmers to utilize specific management skills and/or technical knowledge to increase their production efficiency and lastly.
4. Facilitation extension that focuses on getting farmers with common interests to work more closely together to achieve both individual and common objectives.

In addition, the role of the extension officer is primary to work as a "knowledge brokers" in facilitating the learning process among all types of farmers including women, rural youth and other marginalized social groups (Sulaiman and Davis, 2012).

Traditional Extension

Traditional extension model is the most common type of extension in developing countries used by governments. It assumes that agricultural information and technology is available, however, rural farmers do not used the information, farmers do not have any valuable information about their agricultural practices. Therefore, if agricultural information and technologies transfer successfully to rural farmers, the livelihoods improve (Taye 2013; Zakaria, 2013). Traditionally donors and government funded extension, it is rooted in a supply-driven and linear approach of information that focuses fundamentally on agricultural production (Alex et al. 2004; Gêmo and Chilonda 2013; Nkonya 2009) When this approach is applied at national level, AEAS officials and staff in every tier of government obey, ensuring the continuity of extension programs (Swanson, 2008). When traditional extension runs smoothly, it provides rapid communication of the national agricultural goals from ministry level down to farmers (Zakaria, 2013)

The Training and Visiting (T&V) is one the most popular approach used to disseminate agricultural information and technologies. T&V was developed by the World Bank in the 70's, based detailed extension service work schedule for farm visits, training of extension workers by subject matter specialists and reporting (Friis-Hansen, 2004). The schedule allows passing on of technical skills to from extension officers to farmers. Extension officers are trained to conduct farm demonstrations, farmer field days through in-service training courses (Mbo'o-Tchouawou and Colverson, 2014). Transfer of Technology is also another important component of traditional extension (DOA, 2008). Ultimately, AEAS officials at top levels plan and make decisions regarding policy and types of agricultural information, while extension officers transfer such information to farmers (Zakaria 2013)

Government centrally governed, prioritized and controlled planning and decision-making regarding policy, information and technologies. Local farmers are prescribed agricultural inputs and practices, they hardly have an opportunity to be involved in the process (Heemskerk et al., 2006).Some of the critics of traditional extension is the top-down/linear and supply driven approach restricts dual communication channels, between those who prescribe extension services,

extension officers and farmers. There is also a weak and ineffective linkage between research and extension (Mwamakimbula, 2014). Rural farmers are not involved in developing extension services best suited for their livelihood contexts. The long-term exposure of farmers to the supply-driven approach of traditional extension means low demand for technologies (Qamar, 2005). Additionally, Nkonya (2009) stated that traditional extension services fail to integrate indigenous knowledge. This also resulted in farmers having no ownership or association to extension programs and practices prescribed by governments, making them more likely to be unsuccessful. (Asenso-Okyere. and Mekonnen, 2008). The approach has been criticized for being too rigid in terms of fortnightly visits more so during seasons of low agricultural production (Zakaria, 2013).

The diverse responsibilities assigned to extension officer have led to a lack of extensive and regular demonstration, disorganized and ineffective visits to farmers. The traditional extension approach fails to be cost effective, as it requires recurrent spending on travelling in developing countries (Ahmad, undated). In addition, in the age of information communication technologies (ICT) available even in rural settings, traditional extension fails to incorporate the use of mass media to disseminate agricultural information. The failure of traditional extension services has led to meet national government goals (Omotesho et al. 2012). Has led the reform of government-led extension services to make extension service delivery more accountable to farmers, promote transparency and empowerment as core conditions to increase the effectiveness (Bingen and Simpson, 2015). To date the World Bank still loans funding to African government to conduct a range of extension under altered traditional extension approaches such as modified T&V approaches (Davis, 2008). These approaches combine the top-down approaches with demand-driven extension methods in order; mobilize farmers (Kingiri and Nderitu, 2014).

Demand-driven extension

The concept of the demand-driven extension was a concept developed to reform government-led to be more responsive to the rapidly transforming nature of agriculture and the rural sector (Rivera and Alex 2003; Biner and Anderson 2007). The principles of demand driven extension are that (i) services should be driven by the user (farmers) demand, (ii) extension service providers must be held accountable to users, (iii) users have the freedom of choosing their service providers (Chipeta, 2006). One of the main pre-conditions of this extension concept is to decentralize the top-down approach, which promotes the accountability of extension services to smallholder farmers (Chowa

et al., 2013). The demand-driven extension model changed the role of extension agents from extension workers to farmer advisers and facilitators of change. According to Friis-Hansen (2004:10), “Extension agencies are no longer only providers of technologies and advice, but create the conditions necessary for a broader flow of information and knowledge”. The demand-driven extension has also changed the passive role farmers had in the process of developing extension services. Extension officers engage client farmers discuss their agricultural activities and the management of their farming practices (Anandajayasekeram et al., 2008). One of the challenges that identified for this approach is the competency of extension officers to facilitate human development capabilities amongst farmers. Several authors argued that extension officers trained in crop and livestock production do not have the capacity to organize farmers due to the limited or non-existent training they have in social sciences (Chamala and Shingi 1997; Suvedi and Kaplowitz 2016). In addition, due to the pluralistic nature of donor funding questions the sustainability of demand driven extension.

Participatory Extension

The Participatory Extension Approach (PEA) puts emphasis on strengthening farmers' problem-solving capacities from the very beginning, providing a supportive atmosphere that encourages farmers’ self-confidence (Lubis, 2011). Several authors have noted the top-down extension models have caused rural small-scale farmer to be dependent on institutional support reliance (Elahilodhi 2003; Mbo’o-Tchouawou and Colverson 2014). The main values of PEA extension services are as follows:

1. Promote self-reliance amongst farmers, breaking the dependency of on handouts instead rely on their own capabilities and assets.
2. Ownership and control where farmers make their own decisions and lead development activities that affect their lives.
3. Conservation of natural resources: sustainable.
4. inclusiveness through developing initiatives that do not discriminate against any members of the community but rather aim for the total inclusion of all persons, rich and poor, men and women,

5. Building on indigenous technical knowledge: development interventions should always aim to build on local knowledge and draw upon local experiences in problem-solving (Anandajayasekeram et al., 2008).

This approach goes further than demand driven extension, as farmers not only demand their desired extension services. Also activating participants in planning and executing various extension services. This builds a sense of ownership of agricultural programs, practices, and outcomes chosen by the farmers. Unlike traditional top-down extension approaches, PEA recognizes that farmers that rural farmers have inherited indigenous knowledge regarding agriculture (Ajani et al., 2013). Due to climate change and the move to more sustainable agriculture, PEA recognizes that IKS need improvement by incorporating scientific knowledge, to increase the climate resilience of rural communities. PEAs emerged more cost-effective, have greater extension coverage through farmer association, involves women and acknowledge the role of women in agriculture, reinforces learning through purposeful participation and group pressure. The participatory approach to extension is a relatively new approach. There are only three critics to PEA here are only two main critics this approach is that there is a lack of control over the extension programs and difficulties in managing central reporting and accounting (Fleischer et al. 2002; Zakaria 2013).

One of the most popular extension methods in Africa is farmer field schools (FSS). Davis (2009), states that the PEA model in conjunction with FFS is a popular education and extension approach worldwide. Kenya, Uganda, and Tanzania are just some of the African Countries that use FFS as part of their extension services (Davis et al 2010; Taye 2013). Farmer field schools are traditionally an adult education approach, which assists farmers to learn in an informal setting within their own environment (Khatam et al., 2010). Many donors, governments, and nongovernmental organizations (NGOs) enthusiastically promote FFSs in Sub-Saharan Africa today (Davis et al. 2010). As they the principle of FFS are based on practical methods of education, are farmer-centric and promote environmental and biodiversity protection (Allahyari et al., 2009).

FFS have shown to be especially beneficial to women, people with low literacy levels, and farmers with medium-size land holdings, which somehow characterize rural and small-scale farmers (Davis et al., 2010). In addition, in many countries where the T&V has been a failure, FFS has been as an approach that helps farmers tailor their own agricultural practices to diverse and dynamic ecological conditions (Khatam et al., 2010). Much is still unknown about the long-term

implications of participatory approaches; pertaining key goals of national agricultural goals such as poverty reduction and sustainability. Current knowledge derives from grey literature that deals with cases and the methodology of FFS approaches.

There is no single extension model or approach that works better than another to facilitate national agriculture goals, increase food security, address the extension needs of farmers and promote climate-smart agricultural practices (Karttunen et al., 2015). Hence, the succession and transition from one extension approach to another. For example, Qamar (2005), noted that sustainable agriculture practices may not be demanded by farmers due to the greater investment of resources (time, money and labour) required and/or limited knowledge on emerging issues. Traditional extension approaches maybe necessary at least in the beginning. However, participatory extension has been observed as being extremely beneficial and effective in providing, pro-poor extension and address to the varying extension needs of rural farmers.

2.7.1 Agricultural Extension and Advisory Services in Africa

Agricultural extension has been a vehicle for modernizing agriculture and alleviating rural poverty in many Africa and Sub-Saharan African (SSA) countries (Mutimba 2014; Grits 2014). Agricultural intensification and food production has harmful consequences on the continents soil and biodiversity, causing adverse reactions on climatic conditions farmers wages (Livingston, 2011). As a result, Africa is the only region in the developing world, where on average food person had food production per person has not improved since the early 1970s (Chauvin et al., 2012). This has resulted in a large number of the population becoming chronically food insecure and malnourished. Deteriorating climatic condition and poor extension support continue to put strain the farming activities of millions of small-scale food producers dependent on rain fed agriculture (Lobell, 2014).

Agricultural extension is not a new initiative on the continent, but can be traced back to colonial particularly the ‘land grab’ of African states in South Africa, the first ever extension officers can be tracked back to 1925 (Swanson, 2008). Extension Service were divided into three separate sections, one each to serve the White (Europeans), the Black (native Africans), and the Coloured (people of Indian and other origins) farmers (Qamar, 2013). The government, cooperatives, and the private sector concentrated mainly on the White farmers. For the black farmers, extension

service was part of meeting community needs, focusing on tangible products rather than on developing human capacity (Qamar, 2013).

AEAS remains weak in contrast to other developing regions in South America and Asia (Saliu et al., 2009). This is due to years of negligence of government-led extensions, limited incentives/budgets for supporting public extension, extension concept brought with little or no impact at farmer level. This led to failure of African nations to meet national agricultural development goals of governments (Nahdy and Max, 2013). Chakeredza et al. (2009), argues that the reason AEAS are so weak and lack climate integration in their curriculum, is that the approaches used in Africa emerged from colonial times. The author argues that these extension approaches rely on agricultural philosophies intended for cash crop production for the consumption of colonizing countries. This suggests that current extension approaches, extension learning curriculum and agricultural information is not suited, to African farmers' current socio-economic context, environmental context and rural livelihoods and indigenous knowledge systems. Williams et al. (2008), supports that extension officers therefore do not have the capacities to facilitate rural development adequately. As agricultural education and training focused on increasing production, rather than dealing with the effects of shifting rural changes and demands.

In light of these challenges AEAS in Africa, are following global trends and reforming and modernizing extension systems and services on the continent. This is an urgent response to food insecurity, gender inequality, environmental concerns, poverty alleviation, diversifying market demands and overall the changing socioeconomic scenarios, which pose challenges to the existing technology dissemination (Singh et al., 2013b) According to Sasakawa Global 2000 (SG2000), there are about 150'000 extension workers in SSA from the private, public, and civil society sector (Davis, 2009). This suggests an initiative to provide pluralist wide coverage extension services to farmers. Accordingly, farmers on the continent are starting to increase the adaptive capacities by integrating strategies introduced by research, with existing traditional strategies (Enete and Amusa, 2010)

Swanson and Rajalahti (2010), states that the use of different strategies is important in transforming national agricultural extension and advisory systems in various combinations. These SSA countries also incorporate the demand-driven approach in their existing strategies along Mozambique, for example, currently uses government–led extension and FFS. Rwanda's

extension system uses a participatory, pluralistic, specialized extension employing a bottom-up approach; FFS, Zambia use PEA; FFS, Mali Modified and Training and Visiting (T&V) for both private and parastatal services for cotton; FFS and SG2000 (Davis, 2009).

South Africa continues to experiment with various extension approaches and models. The country uses the public extension model to delivery AEAS to farmers, though it is rooted in the traditional extension approaches other governments in Africa utilized (Akinnagbe and Ayi, 2010). The advantage of T&V puts pressure on the state to organize large numbers of small agricultural extension units into more integrated services, as well extension officers to get out of their offices and services farmers (Anderson et al., 2006). This could explain why traditional extension is still so widespread on the continent. Supplying extension information and training is the governments' responsibility the Directorate of Education, Training and Extension Services (DETES) is a division of South Africa's DOA, their mandate that farmer and other stakeholders have access to appropriate agricultural knowledge and skills for the development of agriculture as an industry (Swanson and Davis, 2015).

Extension services in SSA are following global trends and are moving away from the traditional supply-driven, centralized top-down approaches. The extension approaches are more farmer-centric, decentralized, climate-smart agricultural and pluralistically funded in theory. Davis (2009), states that it is imperative to note that reforming and modernizing extension systems are not to change the systems used, as much as the approaches within the systems. Another challenge that limits the delivery of climate resilient extension is the little knowledge about the quality, performance and capacity of extension systems in SSA (Davis, 2008). This contributes to the lack of clarity of legal policies adopted by governments toward extension system development, reform, and the uncertainty of AEAS ability to meet the extension needs of rural farmers.

2.8 Summary

It is undeniable that agricultural extension advisory (AEAS) have been champions in facilitating poverty reduction and rural development. However, there is a growing gap in the ability of AEAS to enable appropriate and effective climate resilience of rural farming communities. One of the strides being made address these challenges is the reforming and modernization of extension advisory services towards more gender-sensitive approaches, demand-driven and participatory models. However, reformed extension services, still focuses on increasing productivity, building

financial wealth, human capacity and self-sufficiency amongst rural farmers, the needs of smallholder farmers are reflecting the times. AEAS have the potential to build climate resilient extension services in rural areas. Through delivering extension and knowledge information, which increase rural farmer climate adaptation. Nevertheless, climate information in relation to agricultural extension as a theme explored in literature. Especially, concerning formal and informal training of extension officers, types of climate information they disseminate and its suitability in address smallholder farmer's needs.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The study used an integrated research method, which employs both qualitative and quantitative methodologies to collect data on public Agricultural Extension and Advisory Services and the extent of their challenge to meet the climate information needs of smallholder farmers. The study was conducted in Limpopo province over two districts in two local municipalities per district; Mopani district: Maruleng and Tzaneen local municipalities also Vhembe district: Mutale and Musina local municipalities. The Limpopo Department of Agriculture and Rural Development (LDARD) as a public provincial agricultural institution, assisted in identifying the study areas, based on the severity of climate change impacts, predominantly drought. In the study Agricultural Extension Officers (AEO) from Crop and Livestock production and their service centre heads, participated in this study.

3.2 Description of the study areas

Limpopo is South Africa's northern most province, lying within the great curve of the Limpopo River. The province borders the countries of Botswana to the west, Zimbabwe to the north and Mozambique to the east. It also has five district municipalities: Waterberg, Capricorn, Vhembe, Mopani and Sekhukhune. Limpopo is in the savannah biome, an area of mixed grassland and trees commonly known as bushveld, the province has a generally semi-arid climate (Brournels, 2014). Limpopo is a summer-rainfall region; the northern and eastern areas are subtropical with hot and humid summer temperatures average 28°C with mist in the mountains (Mpandeli, 2014). Winter is mild and mostly frost-free with temperatures averaging 15°C. Rainfall averages from around 800 mm per annum in urban areas to over 1500 mm per annum in the rural and mountainous (Mpandeli, 2006).

Limpopo is South Africa’s “fruit basket”, producing up to 60% fruit, which consists of tropical fruit that include bananas, litchis, pineapples, mangoes and pawpaws as well as a variety of nuts. The province also produces thousands of tons of potatoes, sunflowers, cotton, maize, peanuts and table- grape crops (Brournels, 2014) The climatic conditions in the province allow for double harvesting seasons, which results in the province being the largest producer of various crops in the agricultural market (Brournels 2014).

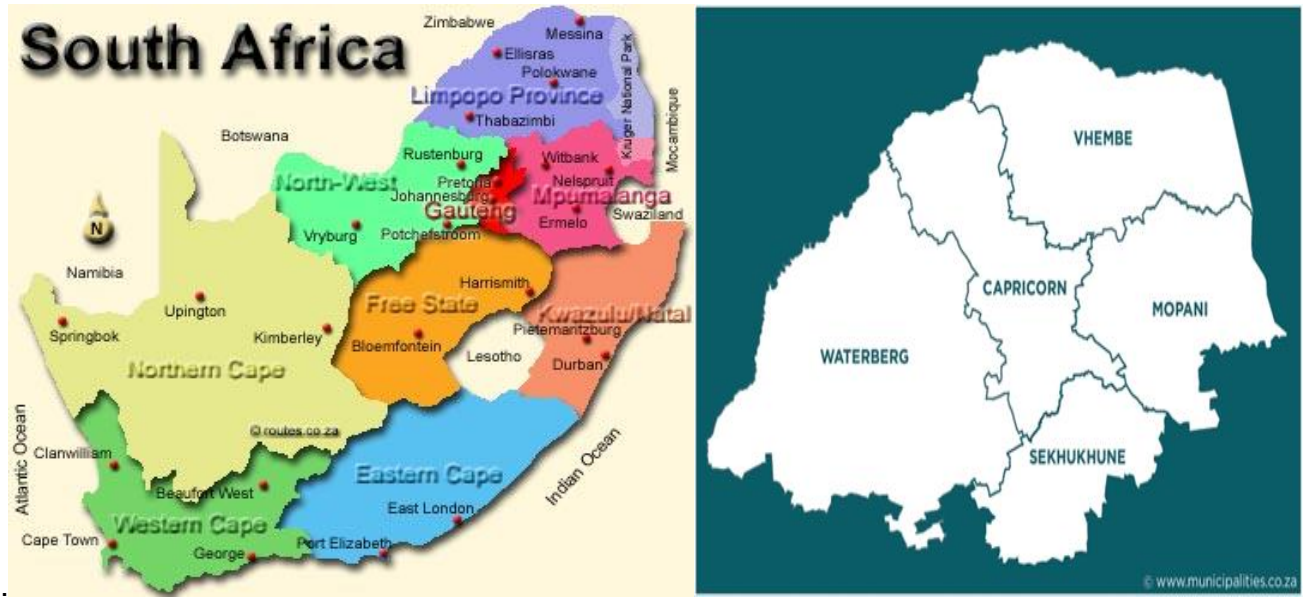

Figure 3.1: Limpopo on the South African Map and its five district

Mopani district municipality

Mopani district municipality is located within the north-eastern quadrant of the Limpopo province. It has five municipalities Phalaborwa, Greater Giyani, Greater Elsabe, Greater Tzaneen and Maruleng, and the District Management Area (Brournels, 2014). The main economic sectors of this district municipality are Mining (30.1%), community services (22.6%), trade (14.6%), finance (14.6%), transport (8.2%), agriculture (3.2%), electricity (2.8%) and construction (2%) (Stats SA, 2011). According to Oni et al. (2012; 13),"Mopani is responsible for contributing about 28.25% of the total agricultural GDP in Limpopo.

Tzaneen local municipality was one of the two municipalities chosen as a study area in the Limpopo province. The local municipality is in the eastern quadrant of the Limpopo province within the Mopani district municipality. The Greater Tzaneen Municipality has a population size of 390 095, which is the largest municipality in terms of population contribution (36%) in the Mopani District. There is a population of 96% black African, with whites second at 3%, and coloureds less than 100 in number as per Census 2011 results (Stats SA, 2011). The official unemployment rate is 36.70% and 48.50% unemployment rate amongst youth from 15-34 years old. The education rate of individuals 20 years and older with no schooling are; 18.70%, Matric 21.80% and Higher education at 8.70% in the Greater Tzaneen local municipality (Brournels, 2014).

There are 125 rural villages in the local municipalities, with almost 80% of the households located in these villages (Stats SA, 2011). There are 108 926 households of which 36 793 are Agricultural households, 47.80% are female headed with a household average of size of 3.50. The specific activities of these Agricultural households are vegetables (23.7%), other crops (27.7%), Livestock (18.1%), poultry (24.8%) and other (5.8%). The income categories of amongst these agricultural households range from no- income (34. 3%), R1-4 800 (4.0), R 4 801 -38 400 (50, 5%), R38 401 –R307 200 (9, 2%) and R307 201 or more (0.8%) (Stats SA, 2011).

The Greater Tzaneen municipality experiences sub-tropical climate, normally receives about 881mm of rain per year, with most the rainfall occurring mainly during mid-summer (Chinyimba, 2012). The municipality receives the lowest rainfall (5mm) in July and the highest (182mm) in January. The average midday temperatures for Tzaneen range from 29.1 °C in January to 21.9°C in June; the region is coldest during July at an average of 6.3°C (Chinyimba, 2012).

Maruleng Local Municipality is the second study area, situated in the south- eastern quadrant of the Limpopo province within the Mopani District Municipality. Maruleng Municipality has a population size of 94 857, which is the smallest municipality in the district in terms of population size, contributing only 9% to the total population in Mopani District and is predominantly rural (Brournels 2014,). The majority of the population (95%) are black African, with the white population constituting 3,7% and other population groups combined forming only 0,8 % of the population (Brournels 2014). The official unemployment rate for this local municipality is 39.90% and 51.20% amongst the youth age 15-34 years old (Brournels 2014, p208). The education rates of individuals 20 years old with no schooling are 20.90%, Matric 18.50% and Higher education at 7.00 % (Stats SA, 2011).

The main economic source for this local municipality is Agriculture, there are total of 24 470 households, with 9 427 characterized as agricultural households (Stats SA). The agricultural households participate in these types of agricultural activities; livestock only (65.7%), mixed farming (7.0%), crops only (14.9%) and other (2.4%).The income category of these agricultural households range from no income (42.2%), R1–4 800 (2.6%), R4 801-38 400 (46.5%), R38 401 - 307 200 (6.4%) and R307 201 + (0.6%) (Stats SA, 2011). Maruleng Municipality experience average temperatures of 16˚C to 31˚C in the summer months, with the highest amounts (75%) of rainfall occurring between November and February

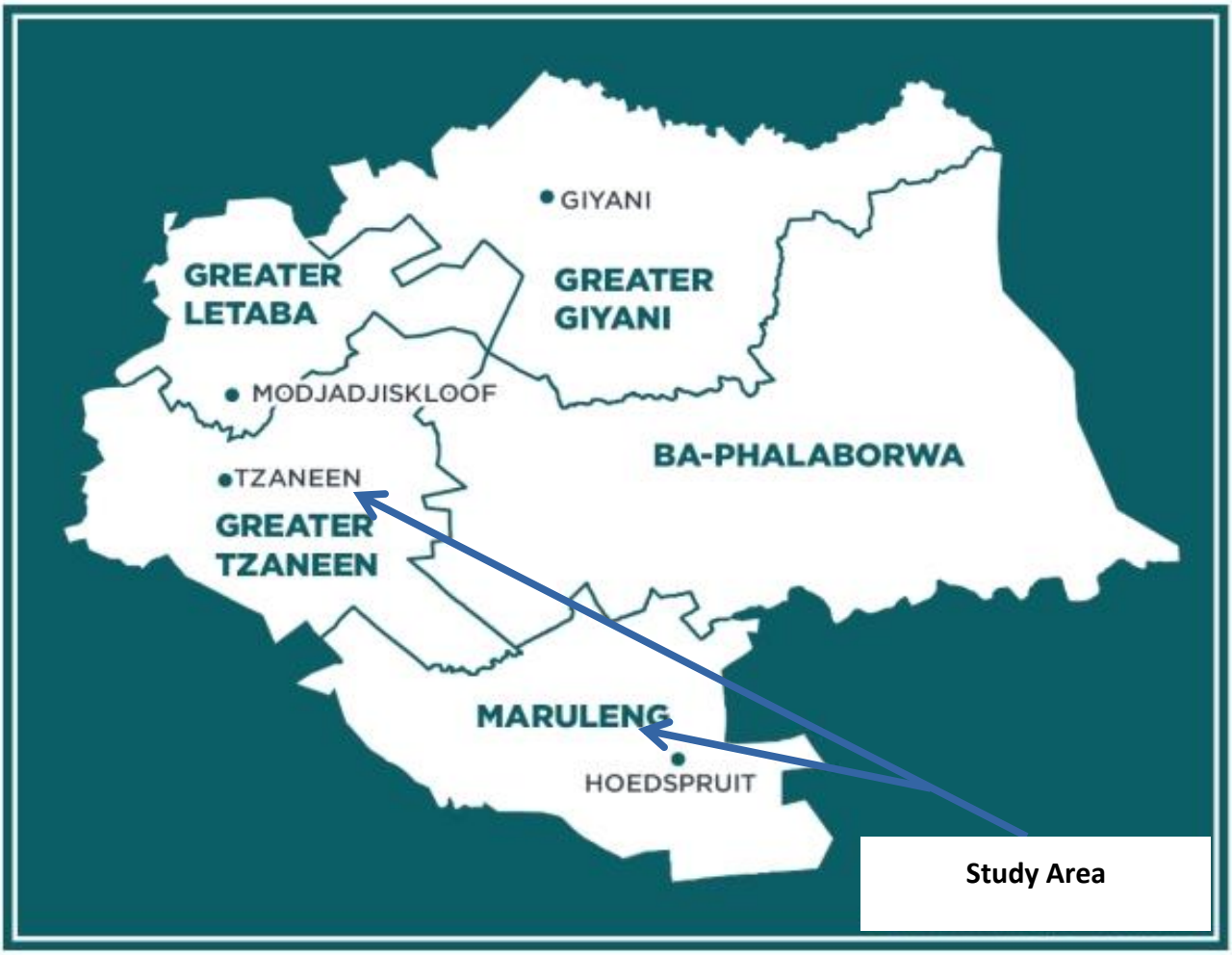

Figure 3.2: Greater Tzaneen and Maruleng local municipalities

Vhembe District

Vhembe District Municipality is located in the northern part of the Limpopo province. It shares borders with Zimbabwe and Botswana in the north-west and Mozambique in the south-east through the Kruger National Park (Brournels, 2014). The Limpopo River valley forms the border between the district and its international neighbours. It is comprised of four local municipalities: Musina, Mutale, Thulamela and Makhado. The district municipality covers a geographical area that is predominantly rural. The district municipality is also legendary cultural hub, and a catalyst for agricultural and tourism development (Stats SA, 2011). The main economic sectors of the district municipality are Mining, Community service, finance and Agriculture. Agriculture in the municipality contributes 22.8 % towards Limpopo's agricultural GDP (Oni et al., 2012).

Musina Local Municipality is the northern most towns in South Africa. Situated close to the Beit Bridge border post between South Africa and Zimbabwe, it is the main entry point into the country from countries north of South Africa (Brournels, 2014). The local Municipality has a total population 68,359. Musina is a multi- racial municipality, due to the influence of the mining industry and the Beit bridge border gate, however 94% are characterised as black (Stats SA, 2011) Only 50% of the population in the municipality speaks Tshivenda as their first language, followed by 8, 8% who speak Sesotho. The local municipality is also dominated by individuals aged 15-36, which is unusual in this area. The official unemployment rate for Musina is 18.7% and 22.5% for youth unemployment (Stats SA, 2011). The education rates for individuals 20 years and older are; no schooling 11.3%, Matric 21, 6% and Higher certificate 6.8%. (Stats SA, 2011)There are a total 20,042 households with 2,261 of them being agricultural households. These agricultural households participate in agricultural activity such as crops only (40.0%), animals only (39.0%), mixed farming (12.6%) and other (8.4%). The income category of these households ranges from no income (21.4%), R1-2 800 (4.3%), R4 801-38 400 (55.9), R38 401 -R307 200 (14.4%) and 307 201 + (18%) (Stats SA, 2011).

Musina Local Municipality experiences hot semi-arid climate, with extremely high temperatures throughout the year (Mpandeli, 2006). The average rainfall is 372 mm and occurs in the summer months October-April. Winters are extremely dry with 0mm rainfall/precipitation from June to August. Droughts in the municipality frequently occur in the winter months (Mpandeli, 2006). Erratic summer droughts are becoming common due to rainfall patterns becoming infrequent and very little rain occurring in the summer months.

Mutale Local Municipality lies in the far north- eastern part of the Limpopo province, bordering the Republic of Zimbabwe in the north and the Republic of Mozambique in the east through the Kruger National Park. The municipality's main economic sectors are Mining, Tourism and Agriculture (Brournels 2014, p215).There is a total population of 91 870 with an official unemployment rate of 48.8%, and youth unemployment rate at 62.2% (Brournels, 2014). The education rate of individuals 20 years and older are no schooling 18.8%, matric 18.8% and higher certificate 7.8% (Stats SA, 2011). The municipality serves almost entirely rural communities. The municipality makes up 7% of the entire Vhembe district population. More than 85% of the population lives in rural/ tribal areas (Stats SA, 2011).

There are 23 751 households, with 12 754 being characterised as agricultural activity Mutale local municipality. These households participate in activities such as animal only (41.4%), crop only (38, 1%), mixed farming (18.7%) and other (1.7%). The income ranges of agricultural households in this local municipality are no income (36.0%), R1-4 800 (5.8%), R 4 801-38 400 (44.7%), R38 401 –R307 200 (11.5%) and R307 201 (0.7%).

Mutale receives an average rainfall of about 681mm per annum, with a significant amount of rainfall occurring during the summer months. The lowest amounts of rainfall (2mm) occur in July, while the highest (137mm) (Brournels, 2014). Average temperature range from 29.9 C in summer months and drop to 7.7 C in the winter months.

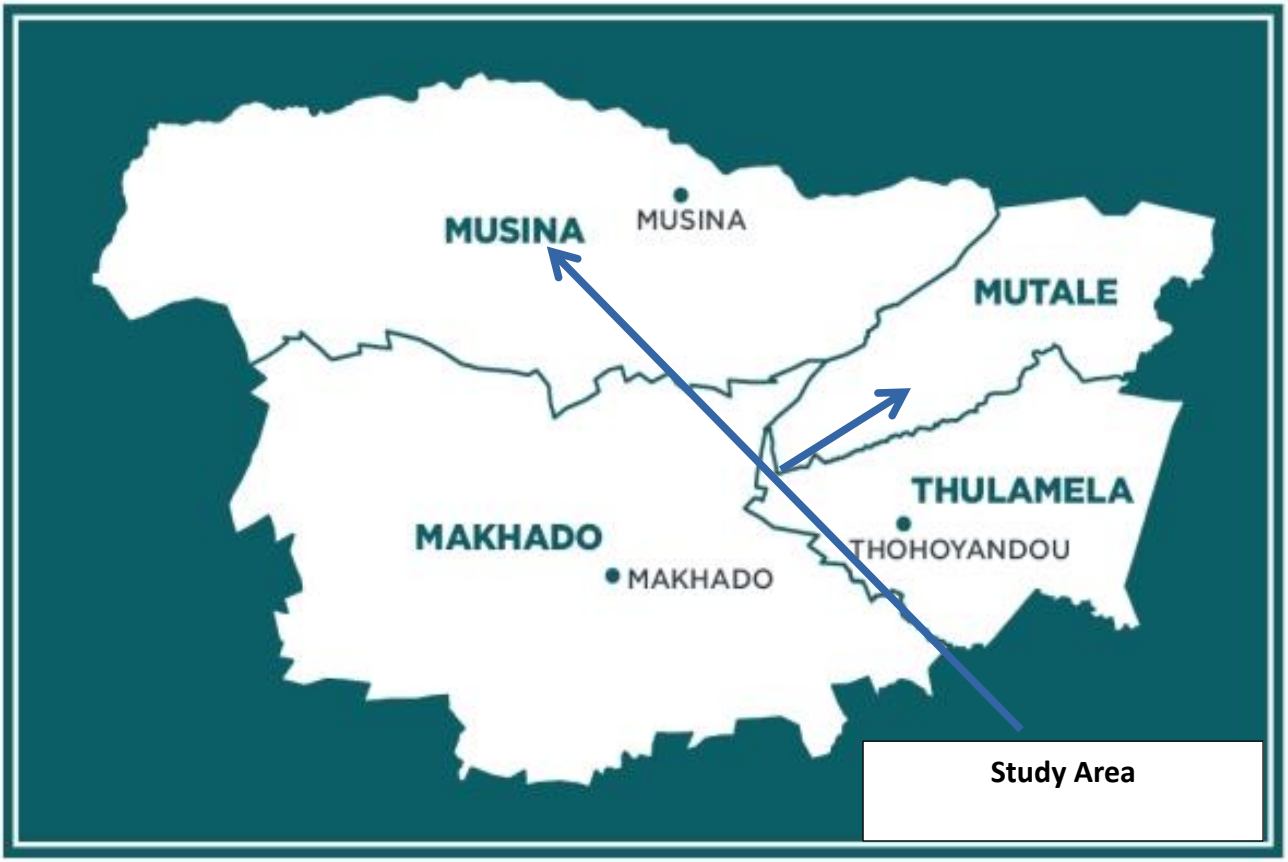

***Figure 3.3*: Musina and Mutale Local Municipalities**

3.3 Sampling Techniques

The populations for this study were both crop and livestock Extension Advisory Service Personnel from the public sector and one farmer's association group per district municipality.

This study used non-probability sampling using judgmental sampling commonly known as purposive sampling (Creswell et al., 2011). With this type of sampling, participants are chosen to be part of the sample with a specific purpose. For this study, identification of the sampling unit relied on their knowledge and employment as AEAS personnel, agricultural extension systems, farming systems and interactions with smallholder farmers (Latham, 2008). The sample had 90 participants consisting of both were men and women. Within the sample unit, four senior managers were identified as key informants and four AEAS Service Centre were selected per district municipality. Also within each district municipality, one farmer association group per district municipality was identified to participate in the study. There was no criteria used to select farmer associations, selection depended on availability and identification by AEOs.

3.4 Data collection techniques

Before applying the integrated research methods approach and conducting the study, a preliminary visit to the Limpopo took place to present to research proposal for this study to LDRAD. This step, assisted in gaining the necessary contacts, support and information that made the study possible, in Limpopo.

Qualitative Approach

This study used Participatory Rural Appraisal (PRA) techniques such as semi-structured interviews, key informant interviews, questionnaires and focused group discussions and collected qualitative data. A discussion is these tools is below.

Key informant interviews conducted aimed to gain a general perspective of the state of Agricultural Extension and Advisory Services and climate change within public extension. Two key informants per study areas' district were selected, making a total eight key informants. The selection of key informants conducted using the criteria from Zueew and Wibers (2004), state in order to conduct key informant interviews, participants are required to have vast knowledge, and/ or experience and involvement in the subject matter and environment/ community.

LDARD assisted in identifying key informants in the Agricultural Extension Services through the key Informants farmer association groups were identified. The Key informants further provided information about the areas most affected by climate variability and various agricultural activities of smallholder farmers within their local municipalities. The criterion for selecting Municipal

Mangers and Service centre heads as key informants were based on their knowledge and experience in the field of Agriculture and Extension, public extension policies and its mandates and in-depth institutional challenges. Data from the key informants was collected using semi-structured interview (Appendix A).

The semi-structured interview questions for the key informants were formulated before conducting the interview (Narayanasamy, 2009). According to Harrell and Bradley (2009), semi- structured interviews are a tool that is well suited for exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enable probing for more information and clarification of the answers. The purpose of semi-structured interview allows participants to answer freely as this type of interviewing is informal to give rich and descriptive answers that give in- depth insight on their experiences and attitudes (Harrell and Bradley, 2009). The questions in the semi –structured interview aimed to answer the research objectives, from the perspective of Service Center heads.

Focus group discussions were conducted using focus group discussion guidelines (Appendix B). The aim of the focus group discussions are helpful in identifying and obtaining preliminary information about beliefs, ideas, opinions, attitudes and behaviours about the topic of the study. The advantage of focus groups over individual interviews is that the comments of one participant can generate comments from other participants. These types of discussions can be very productive, researchers and interviewers benefit from the ideas generated in these discussions (Narayanasamy, 2009). A large quantity of information can be collected often more quickly and at a lesser cost n a short amount of time, than via individual interviews. Focus Group Discussions were used to add details to the quantitative data.

Quantitative Approach

With the expertise and authority of LDARD senior managers' possess, they helped to identify field extension advisory personnel and organized the personnel into one setting.

The criteria for identifying field extension and advisory personnel was; their expertise had to be crop extension, regular interaction with smallholder farmers, and knowledge of local farming practices. Each field AEO received questionnaires survey investigating the perspective and

opinions of those who have realist insight on the needs and challenges of smallholder farmers at grass root level.

Both open and closed ended questions featured in the questionnaires. The questionnaires were checked immediately to ensure all sections in the questionnaire had been completed and void of error. This allowed enumerators to clarify any unclear response before leaving the field. Conducting the focus group discussion was extremely cost effective and was advantageous, as it allowed several people at once, in a short amount of time to participate. According to Veal (2006), focus group discussions allowed the research to observe the interaction and non- verbal cues within the group. The participants are also able to support each other when points are discussed, which has the potential to evoke deeper conversation and views on the subject matter (Overlien et al., 2005). Key informant interviews, semi- structured interviews were all recorded on tape, and notes were taken whilst focused group were recorded via video. This process allowed minimized the researches bias on topics within the study.

3.5 Limitations of the study

Most of the AEAS personnel were willing to participate. However, participants complained about suffering from interview fatigue resulting from the various projects and research projects, which they have to accommodate being coordinated every year, which subsequently affects their workload. In addition, extension officers voiced that these research projects promise to notify the participants of the results and recommendations of these studies, but never receive any report, which made AEOs sceptical to participate. To avoid this we notified participants of the scheduled times, met the extension officers at their office and left questionnaires to be completed collected, at various times during the study period when participants were not available. During data collection, some obstacles were experienced in regards to the sampling size. The sample size decreased from 120 to 90 due to AEOs attending training courses and others being on leave.

3.6 Data Analysis and Presentation of results

The data was coded and entered into the IBM Statistical Package for Social Science (SPSS) 23. To test whether the proportions were different in each group, the Pearson's Chi- square ($\chi 2$) test of independence with $\alpha = 0.005$ as a criterion for significance was used, content analysis was also applied. The results were presented in Chapters 4, 5 and 6 with the main conclusion and recommendations presented in chapter 7.

3.7 Summary

This methodology chapter briefly gives the description of the study areas and the methods and tools used for data collection. This study was conducted in areas of Kwa-Zulu Natal and Limpopo Province from 21 September to 3 October 2015. This study used PRA tools such as semi structured interviews, focus group discussions and questionnaires in order to ascertain results to measure the 3 study objectives, which were to (1) Determine the climate change awareness of extension officers and their level of understanding of the climate change. (2) To assess the inclusion of the climate change concept in the curriculum of agricultural extension officers. (3) Evaluate the perceptions of agricultural extension officers regarding the suitability of the climate information they disseminate to smallholder farmers.

CHAPTER 4: Exploring the Gender Perspectives of Agricultural Extension Officers in Relation to the Climate Change context

4.1 Introduction

This chapter presents an analysis of the characteristics of Agricultural Extension Officers (AEOs) from the Limpopo Department of Agriculture and Rural Development (LDRAD), in the Mopani and Vhembe Districts. This chapter aims to give the general characteristics of the participants that include their age, gender, level of education, academic training and work experience, presented in Table 4.1. Table 4.2-4.4 presents gender-disaggregated perspectives of Agricultural Extension Officers (AEOs) on climatic vulnerability, their knowledge of climate change and their sources of climate information.

4.2 Gender

In the study males dominated Agricultural Extension Advisory Services (AEAS) as 68.9% of the participants were male with only 31.1% females. Oladele (2015), also reported similar findings in the North West province of South Africa, where 76% AEOs were male and 24% were female. According to Hart and Aliber (2012), there is a bad fit between the gender of farmers and that of extension officers in South Africa. Black African female farmers dominate the agricultural sector of South Africa, yet the majority of extension personnel are males. This highlights the gender misalignment between the demography of the clients and that found in AEAS within South Africa. Societal, cultural, religious and traditional beliefs that have historically reserved agricultural enterprises for men lead to the lack of females in AEAS. However, this scenario is starting to change through government encouraging gender equality through employment. Mbugua (2014) argues that increasing the number of female AEOs would significantly improve service delivery. Believing that female farmers may feel more comfortable interacting with fellow female AEOs particularly when dealing with agricultural information that involves decision making at the household level.

4.3 Age

The majority (75.6%) of AEOs were between the ages of 31 and 59 years, followed by 20% who were less than or equal to 30 years of age. AEOs who were 60 years old were less prevalent. That suggests that the majority of AEOs in the study were middle aged. This is in line with findings by

Flor and Hazelman (2004), which showed that most extension workers employed within local Indonesian governments were over the age of 40 years, belonging to “old school” information and communication methods and are waiting retirement.

Table 4.1: Sample Characteristics

Variables		Gender of Participants			Significance level
		Female (%)	Male (%)	Total (%)	
Districts	Mopani	57.1	46.8	50.0	0.247
	Vhembe	42.9	53.2	50.0	
Age	≤ 30	17.9	21.0	20.0	0.191
	31 – 59	82.1	72.6	75.6	
	≥ 60	0	6.5	4.4	
Education level	Diploma	25.0	12.9	18.9	0.089
	B. Tech/Degree	32.1	50.0	47.8	
	Postgraduate	42.9	37.1	33.3	
Specialization	Agricultural Science	14.3	30.6	24.5	0.050
	Agricultural Extension	14.3	16.1	15.6	
	Rural Resource Mngt.	17.9	12.9	14.4	
	Crop Production	17.9	11.3	14.4	
	Livestock Production	7.1	14.5	13.3	
	Farm Management	14.3	8.1	10.0	
	Agricultural Mngt.	10.7	6.5	6.7	
	Other	3.5	0.0	1.1	
Work Experience	≤ 5	50.0	47.8	22.2	0.127
	6 -15	42.9	50.0	20.0	
	16-19	25.0	37.1	35.6	
	≥ 20	21.4	22.6	22.2	
n		28	62	90	

4.4 Education level

There were statistically significant differences between the education levels of female and male AEOs (p=0.089). It was unexpected that more female extension officers held more post graduate degrees (honours, masters and Ph.D) than their male colleagues do. Males were more likely to have a degree/B. Tech qualification. This finding suggests female extension officers were more educated than their male colleagues. Williams et al. (2008) found similar gender distribution in education levels, in six out of nine provinces in South Africa. The majority (47.8%) of extension

officers held degree/B. Tech qualifications. This was unlike findings by Oladele (2015), who found diplomas qualifications were the most common educational qualification amongst extension officers in the North West Province.

Similarly, Agunga and Manda (2014) found the majority of Malawian extension officers either had the junior certificate of education (equivalent to South Africa's matric certificate) or a diploma qualification. Extension officers in Limpopo upgrading their initial qualifications to keep abreast with qualification requirements for promotions, pay increases and other incentives offered by government saw a higher number of them attaining B. Tech/Degree. Several authors noted that the National Department of Agriculture had changed the qualification requirement for hiring extension staff (Rivera 1998; Worth undated; NDA 2009). While previously a diploma was an entry-level qualification for extension officer, a Bachelor of Science in Agriculture is now the minimum requirement.

4.5 Academic training

The results indicated that 24.4% of AEOs specialized in Agricultural Science. There was statistically significant difference in specialization between male and female AEOs ($p=0.050$). Men were more prone to specializing in Agricultural Science, while female extension officers were likely to specialize in either Crop production or Rural Resource Management. This could owe to the majority having studied a qualification that offers a variety of modules from different fields within agriculture. This has allowed flexibility to work in various career paths in agriculture such as AEAS.

4.6 Work experience

Most (35.6%) extension officers have served for about 16–20 years. Equal proportions of participants have more than 20 years (22.2%) and less than or equal to 5 years (22.2%). This could be indicative of a succession plan to replace older extension officers with younger more educated ones. The rest of the extension officers have served for between 6-15 years. These results are comparable to findings Ogulande et al. (2014) who found the majority of extension officers in 10 regions in Ghana to have work experience of 10- 20 years. Similarly, Chizari et al. (2009), found extension officers in Iran had less than or equal to 12 – 17 years job experience. Both male and female AEOs were recent appointments done 5 years ago; but across both gender it seems AEOs stayed for more than 5 years in their jobs. This suggest that AEOs, have in-depth knowledge of the

farmers' needs, areas they service, what programs and policies are effective and which are not. Investment in capacity building and skills training by government would be positive, as it would develop AEOs to better impart knowledge to farmers. The work experience of 16 years above is a good indicator and could benefit the farmer

4.7 Agricultural Extension Officers' climate change perceptions

Table 4.2 shows AEOs'' perceptions on current climatic conditions, temperature changes, rainfall frequency, and drought severity, crop failure and disease, livestock disease and death, and incidences of hunger reported by their clientele in areas they serviced.

There were statistically significant differences showing different gender perspectives in the perception of current climatic conditions between female and male extension officers ($p=0.023$). Female officers were more inclined to perceive current climatic conditions to be 'Bad', while the male officers were of a different perception; they perceived climate conditions to be either 'Good' or 'Constant'. AEO's servicing areas of the Mopani district shared that climate conditions within the district were unfamiliar to the areas. AEOs serving in the Mopani district stated, that climate was normally predictable subtropical; tools such as seasonal calendars are becoming increasingly unreliable as a consequence farmers mistrust agricultural information provided by AEAS. Brodrick et al. (2014), projected similar climatic conditions when analysing downscaled climate model results for the areas of Limpopo, at the district municipality scale.

AEOs serving in the Vhembe district stated that drought conditions were not foreign to the district as it characterized by semi-arid climatic conditions. However, they noted that current climate was reminiscent of drought conditions of 2009-2011. According to focus group discussions, AEOs stated that farmers are under continuous strain and stress due to below normal yields caused due to high temperatures, unpredictable climatic conditions compounded by rural poverty. Mpandeli (2006) found that farmers in the Vhembe district described similar drought conditions based on factors such as food and feed shortages, temperature increases, low rainfall, a decrease in water availability, dying vegetation and animals. O'farrell et al. (2009) also highlighted similar aspects labeling drought in relation to the impacts on the agricultural system.

Temperature changes

There were statistically significant differences in temperature change perceptions between female and male AEOs (p=0.076). Female AEOs perceived an increase in temperature changes, in comparison to more males who perceived temperature changes to have stayed either constant or decreased. AEOs reported high temperatures caused water evaporation, high humidity and contributed to the lack of water availability. This has negatively affected crop growth, the quality and quantity of yields. They also stated that many farmers lost their crops due to black frost attributed to extremely low temperatures. Chijioke et al. (2011), states that throughout Sub-Saharan Africa (SSA) climate change has affected crop production by aspects of climatic variability and stemming largely from average temperature fluctuation.

Drought Severity

The result indicated statistically significant differences in perceived drought conditions between male and female AEOs (p=0.078). Women were more inclined to notice drought severity to have increased, in comparison to men who were more likely to notice drought severity to have stayed constant. Findings are consistent with Mpandeli et al. (2015), who reported that Limpopo province has been experiencing extreme frequency of severe prolonged drought occurring in different districts. These prolonged drought conditions is attributed to the complex interaction between human beings, agriculture and wildlife all vying for the already exhausted degraded scarce and depleted natural resources i.e. land, water, and soil. This pressure, over-time has led the environment to become rapidly susceptible to future extreme weather occurrences such as droughts and flooding, to some extent explaining the drought severity in the study area.

Crop Failure and Disease

Results indicate statistically significant differences in incidences of crop failure and diseases perceptions between female and male AEOs (p=0.086). Women were more inclined to perceive increased incidences of crop failure and disease to have increased. In comparison, to men who were more inclined to perceive incidences of crop failure and diseases to be either constant or were uncertain. The traditional and cultural role of women as household food producers, which has also translated in more women in the study specializing in crop production than men, results in high levels of awareness of crop failure and disease.

Table 4.2: AEOS' perceptions on the impacts of climate change

Variables		Gender of Participants		Total (%)	Significance level
		Female (%)	Male (%)		
Current climatic conditions	Good	0.0	14.5	10.0	0.023
	Consistent	0.0	9.7	6.7	
	Bad	64.3	38.7	46.7	
	Very Bad	35.7	37.1	36.6	
Temperature change	Increased	89.3	64.5	72.2	0.076
	Constant	0.0	14.5	10.0	
	Decreased	3.6	8.1	6.7	
	Uncertain	7.1	12.9	11.1	
Drought Severity	Increased	67.7	57.1	64.4	0.078
	Constant	21.0	42.9	27.8	
	Decreased	4.8	0.0	3.3	
	Uncertain	6.5	0.0	4.4	
Crop Failure and disease	Increased	67.9	35.5	45.6	0.006
	Constant	32.1	48.4	43.3	
	Uncertain	0.0	16.1	11.1	
Livestock Disease and Death	Increased	10.7	45.2	34.4	0.003
	Constant	35.7	32.2	33.3	
	Decreased	0.0	1.6	1.1	
	Uncertain	53.6	21.0	31.1	
Incidences of Hunger	Increased	64.3	32.2	42.2	0.017
	Constant	17.9	33.9	28.9	
	Uncertain	17.8	33.9	28.9	
n		28	62	90	

**The definitions above of Good, Constant, Bad and Very Bad are as observed by questionnaire participants: Good – Generous rainfall with high agricultural yields, running rivers, optimum rainfall and abundant surplus crops for subsistence use and sufficient grazing pastures for livestock. Constant- no comparable apparent change in climate; Bad – Unreliable rainfall with little to poor agricultural yields, less pasture for livestock, high temperatures drying rivers, food insecurity, persistent droughts, unfavourable climate and increase in human disease/illness; Very Bad- Prolonged dry spells, intense heat, Irregular/volatile and destructive rainfall, crop failure, below average agricultural yields, prolonged drought periods, increased erosion, hunger and increased human disease*.

AEOs observed crop failure happening at all stages of growth stages, more so before crop maturity, in both warm and cold season. This is consistent with findings by Hatfield and Prueger et al. (2015), who found extreme high temperatures during the reproductive stage would affect pollen

viability, fertilization, and grain or fruit formation and also winter conditions such as frost were revealed to cause abortion and sterility of developed seeds. Secondly, it was stated that crop diseases and pest have come more difficult to eradicate in the face of climate change (FAO 2008; Smith 2015). Similarly Bewket (2012), reported increased incidences of agricultural pests as one of the manifestations of climate change in Ethiopia

Livestock diseases and death.

Statistically significant differences were detected in incidences livestock disease and death perceptions between male and female AEOs ($p=0.003$). It was more likely for men to observe increased incidences of livestock death and diseases than women. While women were more likely to be uncertain or to report decreases in the incidences of livestock diseases and death. The explanation is that traditionally men have been involved in cattle husbandry, herding and ownership, making it more likely for men to be involved in livestock extension services.

AEOs dealing with livestock production contributed that livestock disease and parasite occurrence amongst livestock farmers has increased. More so, in the winter season (mid-May-July 2014), which has been characterized by numerous cases of lung diseases amongst cattle and sheep due dusty environmental condition. Pneumonia in livestock has also increased in prevalence due inconsistent temperature. Gale et al. (2009) reported that there is strong evidence to suggest that climate change has, and will continue to affect the occurrence, distribution and prevalence of livestock diseases.

During the summer months extension officers reported to have received an increased number of complaints regarding internal parasites such as roundworms and external parasites such as heart water ticks, blue ticks and biting ticks. This has increased the death rates amongst the livestock of resource-poor farmers. According to Makana (2013), more than 2 000 cattle had already died in parts of the Vhembe and Mopani districts since October 2012- January 2013 due current drought conditions and its implications. In addition, due to dry conditions, grazing pastures have become scarce leaving livestock malnourished. Famers to have also reported to AEOs that their livestock often are stuck in the muddy waters in search of water, subsequently dying. AEOs advise farmers to sell, cull their livestock or participate in fruit/vegetable farming as coping strategy to mitigate any livelihood risks. As farmers cannot afford the infrastructure and resources to keep livestock

alive. Similar findings have been supported by Senbeta and Olsson (2009), who identified that conditions characterized by erratic rainfall, led to poor grass regeneration, fodder shortage, water shortage caused heat stress resulting in the likelihood livestock mortality in Ethiopia. Senbeta and Olsson (2009), further noted drought severity significantly increase the susceptibility of livestock to diseases, physical weakening and death due to the long distance travelled for in search of water and pastures.

Incidences of hunger

There were statistically significant differences in incidences of hunger perceptions between female and male AEOs (p=0.017). Female extension officers were more likely to be aware of hunger incidences than men. Whereas, men were more likely to be uncertain or indicate incidences of hunger to be constant. Farmers are subconsciously more comfortable to speak to female officers about their household food security status due to the role women traditionally hold in food production. Furthermore, United Nations Children's Emergency Fund (UNCEP) (2011) found that in South Africa, subsistence farming is prevalent and there is a greater likelihood of higher incidences of hunger, drought conditions already had had a significant impact more so on child hunger and nutrition.

4.8 Extension officers' climate change knowledge

Table 4.3 shows the results from the likert Scale used in the questionnaire, which required extension officers to rate their knowledge of climate change using indicators such as excellent, good, average and below average, used by extension officers to rate their own climate change knowledge. There were high statically significant differences in levels of climate change knowledge between female and male extension officers (p=0.001). Women were more likely to report their climate change knowledge/understanding was "Good". In contrast, to men who were more likely to report their climate change knowledge/understanding was either 'average' or 'below average'.

These findings are in line with McCright (2010), who reported that women were likely to hold more scientifically accurate beliefs than men. McCright (2010) further argues that women have more comprehension about climate change than men. In this regard, a greater percentage (35% to 29%) of women worry about climate change than men, 37% to 28% believe that global

warming/climate change will threaten their way of life during their lifetime and 35% to 28% believe that the seriousness of global warming/climate change is underestimated in the news.

Table 4.3: AEO's knowledge of climate change

Variables	Gender of Participants		Total (%)	Significant level
	Female (%)	Male (%)		
Good	50.0	11.3	23.3	
Average	32.1	56.5	48.9	0. 001
Below Average	17.9	32.3	27.8	
n	28	62	90	

Asadnabizadeh and Araysh (2015), supports that women often have a strong body of knowledge and expertise that can be used in climate change mitigation, disaster reduction and adaptation strategies. Overall, results from extension officers in the study were not in line with finding by Ogulunde et al. (2014), who found that "the majority (60.5%) of Ghanaian extension officers rated their climate change knowledge as excellent followed by 17.9% at Good, 9.5% at Average and 12.1% at Poor."

4.9 Extension Officers' sources of climate change information

Internet

Table 4.4indicates that the Internet (53.3%) was the most popular source of climate change information. . Results also show a statistically significant difference in the use of the internet, amongst male and female extension officers to access climate change information between male and female extension officers (p=0.001). Female extension officers were more prone to prefer the internet to access climate change information, more than their male colleagues. This was not similar to findings by Wanigasundera and Fernando (2012), who found that very few (15%) extension officers from Bangladesh, used the internet; none found climate change information from this Information Communication Technology (ICT).

Fallows (2005) supported the findings on gender preference in the USA and reported that black women were more likely to be online than black men: 60% of black women are internet users compared with 50% of black men. Sheffer and Shultz (2014), further argues, that although women

habitually use the internet for information seeking than men, it is men who pursue and consume online information more aggressively than women. Areas (2012) found that in developing countries such as "Kenya, Cameroon, the Philippians, Colombia, Nigeria, Mozambique, Egypt, India, Uganda and Indonesia it was established that men and women in both urban and rural areas, only 37% of women use the internet, in comparison with 59% of men".

Table 4.4: Means of accessing climate outside the work place

Variables		Gender of Participants		Total (%)	Significance level
		Female (%)	Male (%)		
Internet	Yes	78.9	41.9	53.3	0. 001
	No	21.4	58.1	46.7	
Radio	Yes	28.6	61.3	51.1	0. 006
	No	71.4	38.7	48.9	
Television	Yes	89.3	30.9	48.9	0. 001
	No	10.7	69.4	51.1	
Newspaper	Yes	14.3	48.9	37.8	0. 002
	No	85.7	51.6	62.2	
Social Networks	Yes	78.9	41.9	53.3	0. 001
	No	21.4	58.1	46.7	
n		28	62	90	

Radio

Radio media (51.1%) were the second most popular means of accessing climate information. There was also a statistically significant difference in the use of the radio to access climate information between male and female extension officers (p=0.006). In this case men were more prone to listening to, the radio to access climate change information than women. Similarly, Gustafson (2016), noted that in Rakai, Uganda radio reaches 98 % of men and 86 % of women broadcasting information regarding droughts, seasonal weather forecasts, and livestock production. Archer (2003), further adds, that men favoured radio as a medium of climate dissemination, as men had no reservations in scheduling a regular time to listen to a radio broadcast, in contrast to women who prefer more interactive dissemination allowing them to ask questions. Moreover, women's time was less flexible to be able to sit and listen to radio programs at a fixed time

Television

According to the results, television (48.9%) was the third most prevalent means of accessing climate information. There was a statistically significant preference in accessing information through television between female and male extension officers (p=0.001). Women were more prone to report they accessed climate information through watching television more than men. Findings by African Technology Policy Studies Network in Zimbabwe (ATPS) (2013), found that the respondents perceived television to be the third most important ICT contributing to climate change awareness with 57% of the respondents perceiving the television to be important compared to 32% who perceived it not to be important, while 11% were not applicable. However, in the same study results showed that access to television had a significant negative relationship with the likelihood of a respondent being aware of or accessing climate change information. This could be attributed to television not being seen as a medium for acquiring Information, but rather as a form of entertainment, therefore, the viewer would not be register the information as "serious".

Newspapers

Newspapers (37.8%) was second least popular means of accessing climate information amongst AEOs. Results indicated statistically significant differences in accessing climate change information through reading the newspaper, between male and female extension officers (p=0.002). Men were more susceptible to access climate information through reading newspapers, than women. This was consistent with findings by Gustafson (2016), who established that only 1% of women reported receiving climate information from newspapers in comparison to 99% men. ATPS (2013), further stated that although reading newspapers did not have a significant influence on the likelihood of promoting climate change awareness, respondents' perceived newspapers to be the second most important ICT after the radio in contributing to climate change awareness.

Social Media

Social media (33.3%,) which includes WhatsApp, Twitter feeds and YouTube channels were the least prevalent means of accessing climate information amongst extension officers. There was a statistically significant difference in accessing climate change information through social media, between female and male extension officers (p=0.001). Women were more likely to use social media for climate change information compared to men. Female Extension Officers further added they follow stories about the state of drought condition in the province through news feeds, blogs,

and websites on various social media platforms. They also noted that YouTube channels were a useful tool in educating themselves, as they had more control of the content they felt was relevant to their needs. Twitter, WhatsApp and Facebook were used as a platform for conversations to "broaden their minds" and also circulated local news pertaining to droughts, floods and disease outbreaks in their locales.

This result was in line with findings by Clifford (2014), who reported that women in the USA dominated social media. Furthermore, 58% women often consumed news on social media more than 42% of their male counterparts. Shezi (2014) further supports that although South African women have less access to the internet, they use social media more the men since 33% women said they have access to the internet, compared to 35% men. On the other hand, 83% of the women said they accessed social media, whereas only 78% of men reported the same.

4.10 Summary

The findings in chapter four indicate that AEAS in the study area are male dominated. However, it was observed during the study that 3 out of4 Service Centre managers were female. Female extension officers were also found to be more educated than their male colleagues. Agricultural science was the most studied qualification, which implies that extension officers have a general understanding of topics linked to agricultural production. This also illustrates that extension officers have between employed according to the National Department Agriculture (NDA) norms and standards minimum for recruitment of extension officers in South Africa.

Overall, extension officers had negative perceptions of the current climatic conditions, with women being more confident in their knowledge on climate change. Men and women were more aware of different aspects of climate change, attributed to their involvement in crop extension for women and livestock extension for men. This also points to the social, cultural and traditional constructs of gender roles lending themselves to extension delivery, in the study area.

Men and women had clear differences in the types of information sources they used to access climate information. The internet was the most popular source of climate change information. Internet users have the control over what content to use in a simplified/non-academic format. Using ICT is consistent with trends seen across public extension personnel in Africa and other developing regions. However, self -taught information, especially through the mass media is often to a large

extent unregulated or not scientifically tested, subject to errors, assumptions and/or has biased institutional influence, which dictates what climate information is pursued or ignored. It is important to investigate whether extension officers have received formal training from educational institutions or informal training from LDARD regarding climate change.

CHAPTER 5: INCLUSION OF CLIMATE CHANGE CONCEPT IN THE CURRICULA OF AGRICULTURAL EXTENSION OFFICER'S FURTHER TRAINING: A CASE STUDY OF MOPANI AND VHEMBE DISTRICT, LIMPOPO

5.1 Introduction

Chapter 5 presents findings on extension officers' coverage of climate change at Agricultural Education and Training (AET) institutions and at their current place of employment. Tables 5.1 and 5.2 present findings outlining AET curriculum provision of climate change education and the extent of climate change education integrated into the curricula at these institutions of tertiary level education.

This chapter also assesses the provision of informal training offered by the Limpopo Development of Agriculture and Rural Development (LDARD) to Agricultural Extension Officers (AEOs). Findings outlining in-service training, provision of climate change training and information, regularity of climate change information and competency levels of extension officers are presented in Tables 5.3 -5.5.

Lastly, channels used to disseminate climate information and the types diffused to extension officers are in Figures 5.1 and 5.2. Saleh et al. (2015), defines in-service training as a process of obtaining specific skills to perform a job better, involving the processes of teaching, informing and educating people. Formal and informal training are vital tools, as they determine the ability of AEOs to transfer knowledge, guide farmers to acquire new problem-solving techniques for sustainable agricultural and rural development.

5.2 Climate change concept coverage in agricultural extension training

AEOs specified whether they had received climate change education within the curricula of their education levels. Table 5.1 shows there were statistically significant differences in extension officers' exposure to climate change between their education levels ($p=0.038$). AEOs with a diploma qualification were less prone to receive climate change education. Whereas, extension officers with either a postgraduate or a B. Tech/degree qualification were more likely to receive climate education.

The finding show a significant difference (p=0.038) in education level and the knowledge about climate change. In the study, the AEOs who only had Diploma qualifications, seemed to have less exposure on climate change concepts opposed to AEOs with postgraduate qualification. This is due to the nature of diploma qualification, as it lacks specialization and focusing more on practical skills rather than theoretical knowledge. Blumberga and Klavins (2010), support that the specialized nature of postgraduate qualifications produces 'subject matter specialist'/in-depth with modules focused squarely on climate education. Whereas, undergraduate qualifications give a synopsis of different topics, producing individuals with 'generalist' qualifications in their field.

Table 5.1: Coverage of climate education at tertiary education level

Variables	Education levels			Total (%)	Significant level
	Diploma (%)	B. Tech/Degree (%)	Postgraduate (%)		
Yes	30.0	32.6	64.7	37.8	0. 038
No	70.0	67.4	35.3	62.2	
n	30	43	17	90	

Several authors suggest that the lack of main streaming and integration of climate change education into agricultural fields of study is due to absence of capacitate by educator and poor staffing at institutions to meet the desired curriculum coverage (Temu et al. 2003; Chakeredza et al. 2008; Lotz-Sisitka et al. 2015). Chakeredza et al. (2009), states that Tertiary Agricultural Education (TAE) curricula that has been used in Africa was adopted from the continent's past colonizers, the authors go on to argue that current curricula are founded on an agricultural philosophy which was intended for the production of cash crops for consumption by the colonizing countries. This suggests that the curricula and training AEOs are exposed to are unsuitable to the current environment and socio-economic context of African farmers. As a result, indigenous knowledge systems, rural livelihood systems and climate change/variability experiences of most vulnerable farmers are ignored.

AEOs expressed that though they acquired "textbook" knowledge from their tertiary qualifications the education did not prepare them to build skills, i.e. technology, advice and services to better interact with farmers. This is comparable to finding by Orusha et al. (2012), who stated that

agricultural education teaching and learning transfer in Nigeria lacked interaction between local farming communities and students at undergraduate level. Hindering the fine-tuning of capabilities in communication, teamwork, management and transferable skills; negatively affects the process of information dissemination on the field. The majority of extension officers after their undergraduate qualification go directly into the field, lacking the mentioned capacities, therefore weakening or even threatening the benefit agricultural extension advisory service delivery to the farmer.

5.2.1 Integration climate change education into tertiary agricultural extension related curricula

Table 5.2 shows statistically significant differences in the extent of integration of climate change information between AEOs'' education levels (p=0.070). More extension officers with diploma qualifications were more likely to indicate that climate change education was a "topic" in their curricula. Whereas, participants with postgraduate qualifications and B. Tech/degrees were more likely to have been taught climate change as either "full modules" or "as a section" within the module. Hinting that AEOs with a diploma qualification have less theoretical knowledge of climate change as a concept, thus requiring more training.

Table 5.2: The extent of climate education integration into tertiary qualifications curricula

Variables	Education levels			Total (%)	Significant level
	Diploma (%)	B. Tech/Degree (%)	Postgraduate (%)		
Full module	10.0	14.4	41.2	17.8	
Section	40.0	39.5	17.6	35.6	0. 070
Topic	50.0	46.5	41.2	46.7	
n	30	28	62	90	

UNESCO (undated) supports these findings and states that rather than establishing environmental education as a new subject, most countries have opted to infuse environmental education objectives and strategies into the existing curricula. Focus group discussion also revealed that AEOs better understood climate change under the concept of sustainable development rather than an agricultural production perspective. When they started working in the field they also understood climate change in relation to agriculture. According to UNESCO (2015:25), in most developing countries, climate change education is incorporated into sustainable development policies. In

South Africa, climate education is in the National Climate Change Response White Paper, 2010. The purpose for this is to make sure holistic climate adaptation, mitigation strategies, and solutions, cover all government sectors and industries. This could explain the lack of synergy in the ability to link climate education together with agricultural extension.

5.3 Capacity building in AEAS

Table 5.3 below indicates statistically significant differences in the provision of in-serve training across educational levels of AEOs (p=0.024). AEOs' with a postgraduate qualification were less prone to receive capacity building training i.e. n-service training. Whereas, those with either a B. Tech/degree or a diploma qualification were more prone to receiving in-service training. However, the majority (66.6%) of AEOs s in the study reported not to have received any in-serve training since their employment by LDARD.

Table 5.3: Provision of capacity building to extension officers by LDARD

Variable	Education levels			Total (%)	Significance level
	Diploma (%)	B. Tech/degree (%)	Post graduate (%)		
Yes	50.0	30.2	11.8	33.3	0.024
No	50.0	69.8	88.2	66.6	
n	30	43	17	90	

This finding is consistent with findings by the Department of Agriculture, Forestry and Fisheries (DAFF) (undated), which stated that very few extension officials in South Africa have ever been exposed to formal skills in-service programs; less than 25% of extension staff had been exposed to technical training programmers since joining the public service. Only 9% of extension officers had completed training in communication, 11% had completed project management, 6% had completed computer training and 7% had completed training related to people management and empowerment.

The higher level of in-serve training provision amongst extension officers with diploma qualification could be due to the assumption that individuals with diploma qualification require more training to become at par with their counterparts. This is supported the National framework for Extension-Recovery Plan DAFF (2011), which states that extension officers without the

minimum academic requirement for an extension officer, as recommended by the NDA norms and standards are encouraged to further studying and training.

Several authors have identified poor training of agricultural extension staff as a factor contributing to the relative ineffectiveness in the field of agricultural extension (Tshwana, Undated). According to Mashamba (2012), who assessed the effectiveness of training for extension staff in the Limpopo Department of Agriculture, training provided to the majority extension officers was outdated as it was not relevant to current challenges extension and clients face. Raidimi (undated), further argues that the training functions of DAFF and non-governmental organization (NGOs) generally runs ad-hoc in-service training programs that do not prepare extension officers adequately to deal with the multifaceted challenges of rural agriculture. Furthermore, Masukela et al. (2013) had the opinion that education in South Africa requires training of the workforce to be compulsory. The assumption is that it would re-orientate extension officers to new goals and values, prepare them to cope with unreliable environmental change, train them in new farming and technology methods, providing them with the knowledge and skills to inform upcoming farmers.

5.3.1 Capacity building courses in AEAS

Table 5.4 indicates statistically significant differences in the provision of climate change training between extension officers' work experience (p=0.010). Extension officers with 6-15 years of work experience were more like to receive climate change training. In contrast, to those with either less-than or equal to 5 years work experience or greater -than or equal 20 years.

Table 5.4: LDARD provision of climate information and training

Variable	Work Experience				Total (%)	Significance level
	≤5 yrs. (%)	6-15 yrs. (%)	16-19 yrs. (%)	≥ 20 yrs. (%)		
Yes	20.0	65.6	61.1	55.0	52.2	0.010
No	80.0	34.4	38.9	45.0	47.8	
n	20	18	32	20	90	

AEOs indicated that although training is provided, attendance is low. The workload and limited time often hinders them from effectively attending course. They cannot decide between performing

their key responsibilities and training "going to training cause backlog in the workload". Training workshops are held in close proximity to service centres; this requires AEOs to travel away for several days. The key informant from Vhembe district stated that "*Besides, there is little incentives attending training, if anything there are more cons; time loss at work, transportation constraints and decreased work relationship between themselves and farmers due to the absenc*e".

All service centre managers voiced that organizing training at sub-district level is especially unsuccessful and poorly attended AEOs are often tasked with facilitating training or workshops after going to larger conferences, seminars, training or workshop organized at the provincial or national level. AEOs view the officers facilitating training or courses as their peers. They underestimate the AEOs facilitating the training or course as they feel the facilitator is not qualified or knowledgeable enough to disseminate knowledge to them. These results are consistent with findings by Masukela et al. (2013), who found similar constraints in training provision amongst extension officers of Department of Agriculture, Conservation and Environment (DACE) North West Province, South Africa.

5.4 Frequency of climate information dispersal to extension officers

Table 5.5 implies inconsistency in the dissemination of climate information by LDARD, compromising the relevance of the information that informs coping capacities of farmers. There were also statistically significant differences in the frequency of climate information between Mopani and Vhembe districts ($p=0.021$). AEOs in the Mopani district were prone to receive climate education monthly, in contrast to AEOs in the Vhembe district who were more likely to report they received climate change infrequently (none of the above) or quarterly.

The results also imply a delay in timeliness of climate information delivery, compromising the relevance of the information that informs coping capacities of farmers. These findings are similar to Agholor et al. (2013), who measured the quality of extension services in the Eastern Cape-South Africa, farmers reported they were specifically less satisfied with each aspect of service quality, which included timeliness of delivery, accuracy of service, relevance to farmers' needs/situation and ease of understanding.

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Table 5.5: Regularity of climate information dissemination to AEOs

Variable	Districts		Total (%)	Significance level
	Mopani (%)	Vhembe (%)		
Monthly	35.6	11.1	23.3	
Quarterly	31.1	37.8	34.4	0.021
None of the above	33.3	51.1	42.2	
n	45	45	45	

The key informant from the Vhembe district stated, that climate information is supposed to be disseminated monthly or sometimes weekly (weather forecasts), quarterly (seasonal and extreme weather forecasts). Poor infrastructure and resources limit the regular diffusion of climate change information to rural service centres. These were the same opinions, held by extension officers in the Mopani and Vhembe district, situated in rural areas. AEOs felt their service centres were neglected in terms of resources, infrastructure upkeep, information dissemination and even water and sanitation, in comparison to head offices and main service centres. Similarly, Mashamba (2012) found that the lack of infrastructure such as office accommodation, poor technology and insufficient funds incapacitated AEOs' ability to transfer necessary skills, information, and advisory services to farmers in Limpopo.

Service centres in Musina, Mutale (Vhembe) and Maruleng (Mopani) lacked permanent working internet access that would play a vital role in communication circulars, information, accessing the department's Intranet and work electronic mail (e-mail). In some cases there was a working internet connection, however, the computers, scanners, and printers were not working due to lack of maintenance. This was not the case at Tzaneen (Mopani) service centre. AEOs in stationed at the rural service centres reported that they often resort to using their own cell phone devices and

tablets to access work email and websites, which is costly. AEOs s added that lack of internet access at the service centres significantly limits their ability to research climate-related queries from themselves and farmers, affecting their ability to give accurate advisory services. AEOs in both districts reported they also rely on telephone communication, Service Centres Managers or rely on fellow colleagues from the head office to relay any important or urgent information.

These findings are similar Omotesho et al. (2012), who determined that in Kawara state, Nigeria agricultural extension officers; particularly Extension Agents (EAs) have low levels of access to Information and Communication Technology (ICT). This is despite ICT globally being vital for effective agricultural extension. Tshwana (undated) had the opinion that access or lack of access to the Internet is a major factor in determining the reduction of the information gap, or further widening. If agricultural institutions are to keep up to speed with rapid changes in science and technology, continuing education for faculty members is necessary through a commitment by institutions to improve the information infrastructure and training to ensure AEOs have access to the new information technologies and can use them efficiently.

5.5 Channels used for transferring climate change information to extension officers

Figure 5.1 below illustrates responses to a multiple response question that requested AEOs to indicate, what channels of information by their employer uses to disseminate agricultural information, particularly climate information. The results show that the work email (56%) was the most popular channel extension officers received climate information from LDARD. Workshops, meeting and Conferences (53%) were the second most prevalent channel use. Extension officers stated that the workshops and conferences were extremely informative and useful organizations such as Agricultural Research Council (ARC) speak about topics such as water, soil and land management in relation to climate change. Pamphlets and/or booklets were the third most prevalent channel of information dissemination (48%), followed by meetings (23%) and government provincial website (20%). Training manuals (18%) provided information on seasonal calendars, were least popular channels to disseminate information, which provided seasonal weather forecasts for all districts in Limpopo.

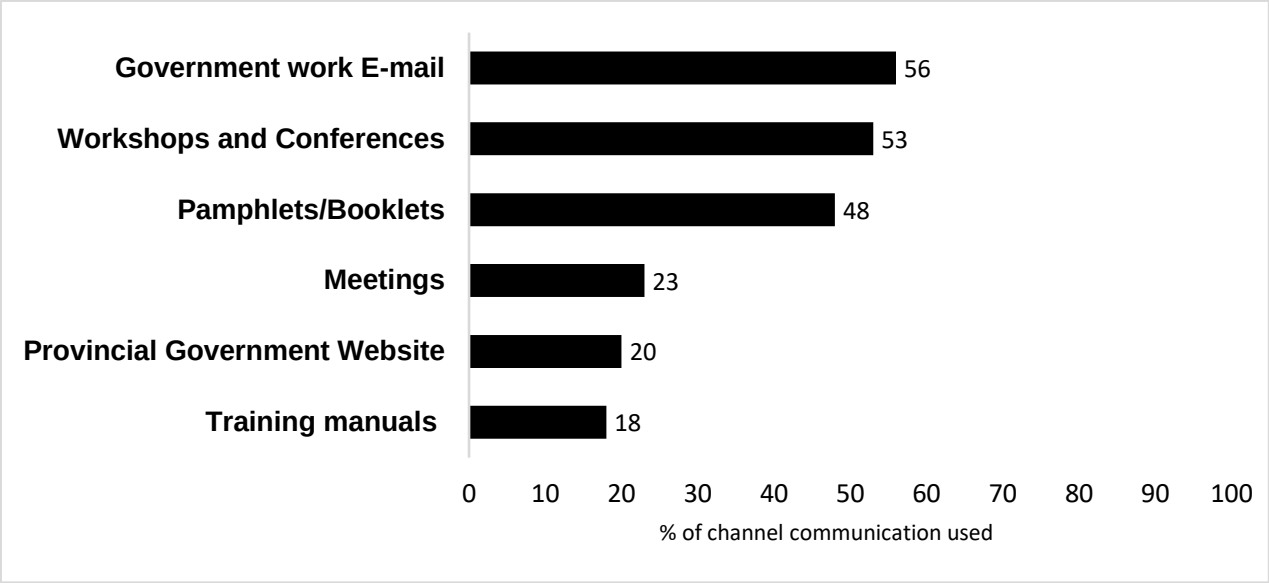

Figure 5.1: Different channels of communication used to transfer climate information to AEOs by LDARD

5.6 Types of climate information disseminated to AEOs.

Figure 5.2 illustrates a multiple response question indicates the types of climate information disseminated by their employer (LDARD), in both Vhembe and Mopani districts. The results illustrate Changes in rainfall (85%) and 'Average temperature' fluctuations (83%), are both of top priority. Followed by 'extreme weather occurrences' (77%) such as heat waves, destructive rainfall and hailstorms were and lastly 'crop and livestock diseases' (50%). Climate information disseminated by to extension officers is similar climate information disseminated, distributed to farmers in semi-arid environments across the world (Kadi et al. 2011; Selvaraju 2012; Mudombi and Nhamo 2014).

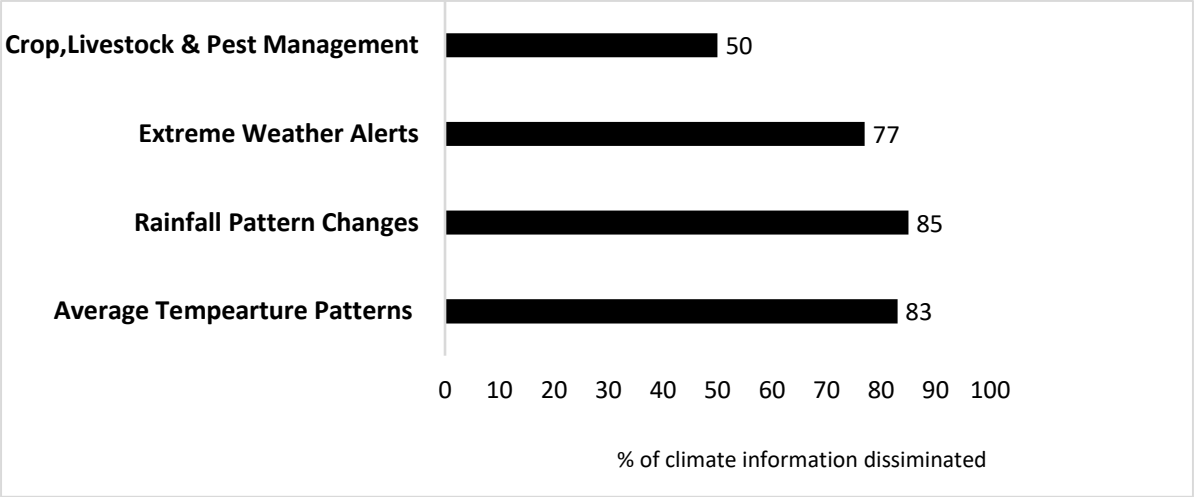

Figure 5.2: Types of climate information disseminated by LDARD

Additionally, extension officers indicated the information received from LDARD comes in general format that theoretically should be easy to diffuse to farmers. However, giving correct terminology in the indigenous languages proves to be challenging and explaining concepts prove to be difficult as AEOs are not aware of how to engage farmers on questions that arise on climate change. Rural farmers prefer their indigenous language to English, as the majority are uneducated. The finding is similar to findings by Kimaru and Antón, (2012), who reported that farmers in Kenya with no formal education (100%) or primary education (65%) did not prefer English as a medium of instruction when disseminating agricultural information. A key informant added that they do their best to be sensitive to the reality through innovative ways, such as "stick markings, counting stones, basic charts, nursery rhymes to ensure that farmers understand, apply information and practices given to us by the Department to dispense to our farmers".

5.7 AEOs competency in disseminating climate change information.

Table 5.6 below shows results from a likert scale type question assessing perceived competency level of AEOs in disseminating climate information. There were statistically significant differences in competency levels between the education levels of extension officers (p=0. 017).AEOs with a postgraduate qualification were more inclined to report they had 'good' competency level in disseminating climate education. Whereas, extension officers with undergraduate qualification were more likely to report their competency levels to be either 'average' or 'below average'. This could be attributed to the self-confidence gained from possessing higher education levels and being re assured by the training received at that level of education.

Table 5.6: Competency level as perceived by AEOs

Variable	Education Level			Total (%)	Significance level
	Diploma (%)	B. Tech/degree (%)	Postgraduate (%)		
Good	2.2	12.2	7.8	22.2	
Average	18.9	27.8	7.8	54.4	
neutral	7.8	2.2	0.0	10.0	0.017
Poor	4.4	5.6	3.3	13.3	
n	30	43	17	90	

The findings are supported by Khan et al. (2011), who established that the competency level of Agricultural Officers in Pakistani improved with higher levels of education from B.Sc. Honours through to Ph. D. Alainati et al. (2010), further argue education and training have a direct and positive link between education and training on job competency. Therefore, this emphasizes the need for continuous education and training to improve individual's competency. In focused group discussions extension officers stated that they have very basic training in climate change and its impacts linked to community development, food security and nutrition. In addition, the lack of frequent training also has a negative impact on the ability to transfer knowledge and build capacities. Raza et al. (2013) stated that in-service training is an important aspect of training as it familiarizes newly recruited extension officers with the organizations' objectives and policies; furthermore, it strengthens and upgrades the professional skills and abilities of extension workers and specialist.

5.8 Summary

Chapter five indicates that the majority of AEOs in the study have not been fully exposed to climate change, prior to their employment in the field of AEAS. Furthermore, those who received climate education pointed out that climate change was mostly addressed in 'sections 'or 'as topics' in their curriculum. This suggests that the climate information gap in AEAS stems from the slow mainstreaming and integration of climate change information. The findings also suggest that meet AEOs have not received in-service training since joining the LDARD. However, individuals with lower levels of education were more likely to receive capacity building training, than those with higher education levels.

LDARD does provide climate information such as ‘average temperature’ and rainfall fluctuations, crop, livestock pest control and disease management. Yet, the poor state infrastructure and ICT in rural service centres delays with AEOs’ ability to receive this information regularly. The findings also showed a significant correlation with newly recruited (less-than or equal to 5 years work experience) extension officers reporting not to have received climate change training, in contrast to those who have served LDARD longer. Lastly, literature has stressed the importance of overall recurrent training of employees in the AEAS, which has an impact on the competency levels of extension officers. AEOs with higher education levels perceived their competency levels to be better than their colleagues with lower education levels.

CHAPTER 6: EXTENSION OFFICERS PERCEPTION ON THE SUITABILITY OF CLIMATE INFORMATION DISSEMINATED TO FARMERS

6. 1 Introduction

Chapter 6 accesses the farming profile of farmers serviced by Agricultural Extension Officers (AEOs) and Figure 6.1 and Table 6.1 presents extension approaches used to disseminate climate information. Secondly, factors such as the types of climate information disseminated, the frequency of climate information dissemination by AEOs, frequently requested climate forecasts by farmers, types of communication methods to disseminate climate education were accessed and presented in Figures 6.2-6.3 and Tables 6.2–6.3. Lastly, AEOs'' perceptions on gender dynamics in climate information use by farmers, correct use of climate information by their farmers and whether the climate information disseminated to farmers was suitable for their farmers; these findings were displayed in Tables 6.4 – 6.7.

6.2 Types of farmers serviced by extension officers

Figure 6.1 illustrates that multiple responses extension officers in the study area mostly serviced smallholder farmers (69%) and subsistence farmers (20%). AEOs characterized their farmers as predominantly illiterate to moderately literate, middle-aged to elderly and resource poor smallholder, farming for both household consumption and market production. Agriculture for most of these farmers is the primary source of income that supports their households, coupled with part-time or sometimes seasonal employment. This is similar to findings by Oni et al. (2012), state that smallholder farming is the predominant agricultural enterprise in Limpopo, contributing immensely towards the province's GDP. Several other authors showed similar trends on smallholder farmers across the Sub-Saharan region (Afenyo 2012; Schaffnit-Chatterjee 2014; Kalungu et al. 2013). Emerging smallholder farmers accounted for 49% of the farmers serviced in the area. Whereas, commercial farmers accounted for the least serviced enterprise of farmers.

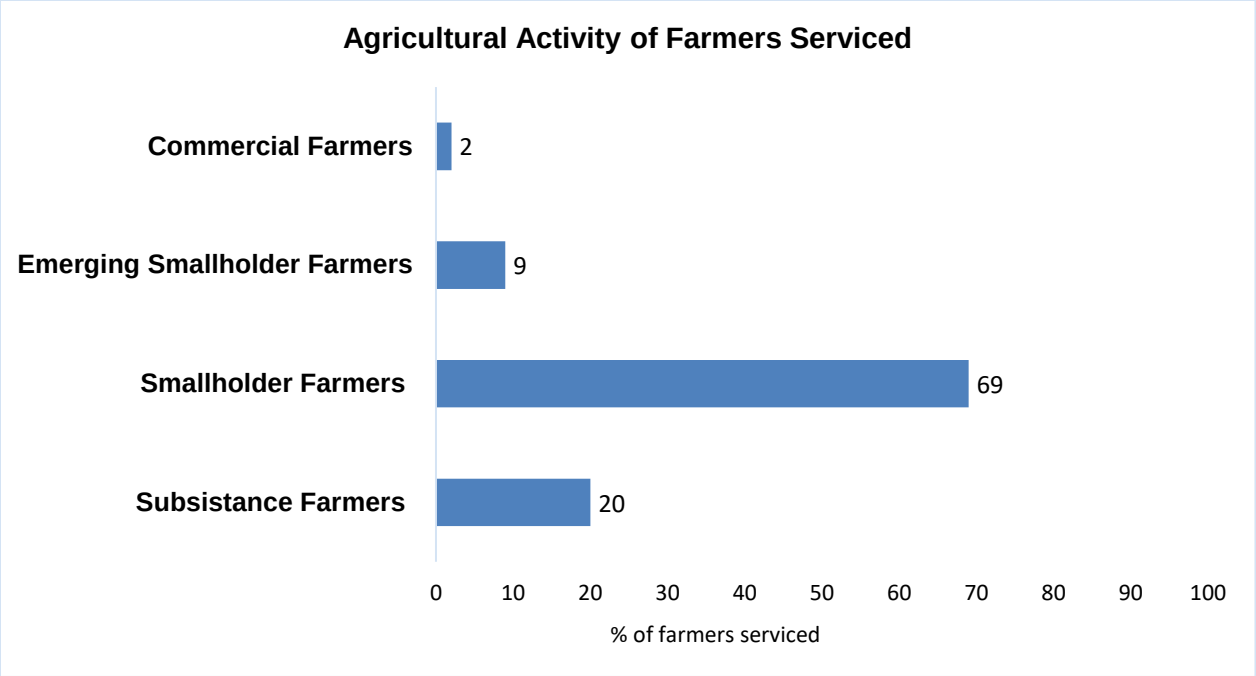

Figure 6.1: Enterprise of farmers serviced by extension officers in the study area

6.3 Extension Approaches used for climate change dissemination

Formal Extension

Table 6.1 indicates that Formal Extension (68.9%) characterized by Training and Visiting (T&V) and the Transfer of Technology (TOT) model were the most used extension approaches. There were statistically significant differences in the use of formal extension across education levels of extension officers (p=0.004). AEOs' with a diploma qualification were more inclined to use formal extension. Whereas, AEOs with either a B. Tech/degree or postgraduate qualification were less likely to use formal extension to disseminate climate information to farmers.

Nkonya (2009), stated that formal extension characterized by the Training and Visit (T&V) methods is still widely implemented within government-led either in its original for modified in Sub- Sub-Saharan Africa. Baloyi (2010), also stated that formal extension, particularly T&V, was the most common form of extension service in Limpopo. Several authors have noted formal extension to be unsuitable in addressing needs of smallholder farmers, especially new challenges linked to climate adaptation and mitigation (Anandajayasekeram et al. 2008; Davis 2009; Akinnagbe and Ajayi 2010; Enete and Amusa 2010; Berthe 2010). Yet, Ekenta et al. (2013), found formal extension through training and visits (67%) was one of the most effective extension

information dissemination methods employed by extension agents in the Kogi State, Nigeria in disseminating organic agriculture practices, used as a strategy to mitigate the effects of climate change. Findings by Mandleni (2011), support that dissemination through formal extension positively and significantly affected awareness to climate change and adaptation by livestock farmers in Eastern Cape, South Africa. Oduniyi (2013), reporting a similar trend in small-scale maize farmers in Mpumalanga, South Africa.

Zeleke and Aberra (2014) in Ethiopia established formal extension to have a positive statistical significance with the adoption of climate adaptation/mitigation strategies such as rainwater harvesting, manure application, and tree planting. However, the same study revealed formal extension to have negative statistical significance in farmers adopting some climate adaptation/mitigation strategies such as the application of modern fertilizers and terrace construction. This is attributed to the failure of the current extension approach; its shortfall in sustaining the process of extension diffusion, the top-down approach of formal extension, lack of understanding of the role of extension in climate change adaptation compounded by the inconsistent participation of the beneficiaries in Ethiopia's extension services (Zeleke and Aberra, 2014).

Table 6.1: Extension methods used to disseminate climate and agricultural information

Variable		Education Level			Total (%)	Significance level
		Diploma (%)	B. Tech/Degree (%)	Postgraduate (%)		
Formal Extension	Yes	80.0	74.4	64.7	68.9	0.004
	No	20.0	35.5	35.3	31.1	
Farmer - farmer Extension	Yes	73.3	34.9	23.5	45.6	0.001
	No	26.7	65.1	76.5	54.4	
Farmer –led Extension	Yes	20.0	25.6	88.2	35.6	0.001
	No	80.0	74.4	11.8	64.4	
Farmer Field School	Yes	6.7	11.6	41.2	15.6	0.005
	No	93.3	88.4	58.8	84.4	
n		30	43	17	90	

Farmer–Farmer Extension

Farmer – farmer (F2F) extension approach was the second most widespread approach used by extension officers. There was statically significant difference in the use of F2F extension across education levels of extension officers (p=0.001). More AEOs with a postgraduate qualification prone to disseminate climate change information using this extension approach. In contrast, to AEOs with either diploma qualification were less prone to use F2F extension to disseminate climate change information. Oduniyi (2013), found farmer- to farmer extension (92.4 %) to be the extension service available to the farmers used to disseminate services and information. Furthermore, several authors have noted that F2F extension had a positive influence on the adoption of adaptive technologies in response to climate change (Deressa et al. 2010; Di Falco et al. 2011). Zeleke and Aberra, (2014), adds that F2F extension has the potential to inspire resource-poor farmers, to teach other farmers to incorporate methods they have developed and found successful in mitigating climate change impacts.

However, Simpson and Burpee (2014), argue that the perception of the F2F approach by many organizations in increasing the sustainability of their programs requires a temporal interpretation of what is meant by sustainability. Within a given locality, at some point, the adoption potential of any new technology will become saturated. Lead farmers that are not connected with some lasting source of new information and training will only have limited opportunity to acquire new skills and information within the time frame of project-based initiatives, and cannot be viewed as a long-term solution to progressive and evolving extension needs, such as those associated with adapting to climate change.

Farmer –Led Extension

Farmer–Led Extension (FLE) is the 3rd most utilized extension approach, there was a statistically significant difference in the use of FLE across education levels of AEOs (p=0.001). Extension officers with a postgraduate qualification were more likely to use FLE. While AEOs with either diploma qualification or B. Tech qualifications were less prone to use FLE to disseminate climate change information.

Findings by Wettasinha et al. (2014), found dissemination impacts using FLE on rural livelihoods and food security generally improved crop diversity and agro-biodiversity that led to greater resilience to environmental hazards; For example, farmers in Zimbabwe adopted farming practices

and strategies that had a positive environmental impact. FLE in Niger had a positive impact on livelihoods and a high significance in improving social and environmental benefits for farming communities. Karttunen et al. (2015), noted that FLE was an effective and successful method to disseminate information regarding climate –smart agriculture in Morogono, Tanzania. The success of FLE could be due to the extensive use of local resources; which are often low-cost and incorporate indigenous knowledge. The approach also allows farmers to take ownership of their learning experience and become innovators of technologies they chose to implement.

Farmer Field School

Farmer Field School (FFS) was the least predominate (15.6%) approach used by AEOs. There were statistically significant differences in the use of FFS to disseminate climate change information across education levels of extension officers ($p=0.005$). Extension officers' with a postgraduate qualification were more likely to use FFS. On the other hand, AEOs s with either a diploma or B. Tech qualification were less prone to use FFS extension methods for climate change information dissemination.

Gwary et al. (2015), stated that FFS educates Nigerian farmers on the environment, climate change, sustainable land and water use. Gwary et al. (2015), adds that the approach also promotes farmers' awareness on the reduction of negative environmental impacts of unsustainable farming practices and the protection of the local environment. According to extension officers using FFS approaches are difficult to disseminate due to limited climate change information and facilitation skills and training they have. In addition, there is no clear indigenous terminology for climate process and concepts, making it challenging to engage farmers on climate change in their indigenous language and not sounding too academic/technical towards in front of an illiterate audience.

6.4 Types of information disseminated to farmers

Figure 6.2 illustrates results from a multiple response question from AEOs, which required them to indicate the types of climate change information they disseminated to farmers. 'Extreme weathers alerts' (hailstorms, heat waves, frost, drought and strong winds) (73%) and associated preventive methods were the most predominate information disseminated, followed by 64% 'water

management i.e. water harvesting and irrigation methods and schedules, 54% 'crop management' i.e. use of climate resilient seeds, invasive species control, cultivators and pesticide application, 'climate Forecasts' i.e. seasonal calendars, short – medium term weather forecast, fluctuations in temperature and rainfall patterns and lastly 28% 'livestock management' i.e., nutrition, disease and vaccinations. These findings are consistent with Afful et al. (2015) who found that public extension services provided similar information to 20 villages in Limpopo concerned with maize production as coping and adaptation strategies against climate variability. Several authors suggested similar climate change information is being disseminated to farmers in semi-arid environments (Churi et al. 2012; Cherotichet et al. 2012; Elias et al. 2015).

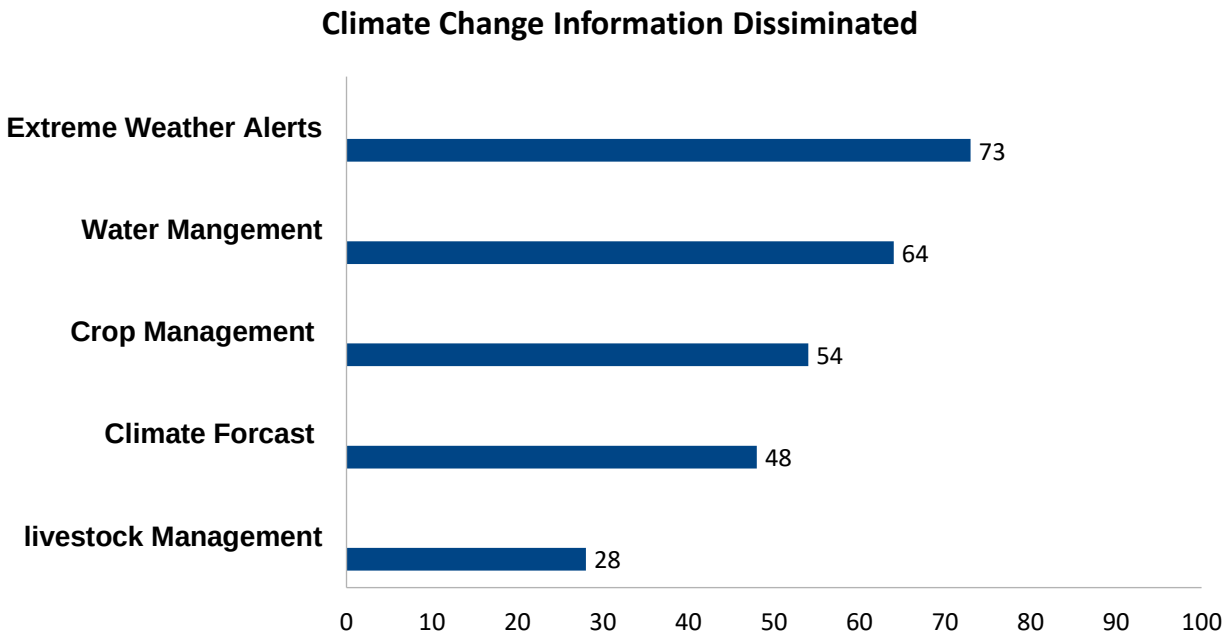

Figure 6.2: Climate information disseminated to farmers

6.5 Frequency of climate information dissemination to farmers

Table 6.2 requested extension officers to indicate whether they disseminated climate information provided by the Limpopo Department of Agriculture and Rural Development (LDARD). There was statistically significant difference in the frequency dissemination of climate change information to farmers, between the Mopani and Vhembe districts (p=0.018). AEOs from the Vhembe district were more likely to disseminate climate change information to their farmers regularly. In contrast, to extension officers from the Mopani district were less inclined to disseminate climate change information to farmers. Extension officers from Mopani District cited

lack of transportation, poor ICT infrastructure, being short staffed and poor coordination within AEAS as reasons for the irregular dissemination of climate change information to farmers.

Table 6.2: Frequency of disseminating climate change information to farmers

Variable	District		Total (%)	Significance level
	Mopani (%)	Vhembe (%)		
Yes	28.9	53.3	41.1	0.018
No	71.1	46.7	58.9	
n	45	45	90	

However, in the Vhembe district only AEOs from the Mutale municipality cited similar constraints to their colleagues in the Mopani district, rural service centre. Extension officers stationed at the Musina rural service centre reported they worked in partnership with a private organization called Timbali Technology Incubator, located within the premises of the Musina service centre. According to the Timbali Technology Incubator's manager, they work in conjunction with the Limpopo Department of Agriculture and Rural Development (LDARD) to provide agricultural extension services that are in line with those of government. Timbali Technology Incubator provides their own extension staff, who each use motorbikes to travel to farmers who are often unreachable due to poor road infrastructure in the area. Extension officers in Musina stated that, the presence of Timbali Technology Incubator has assisted in increasing extension coverage, knowledge sharing and regularity of agricultural information dissemination on their behalf. Other service centres visited in Tzaneen, Maruleng (Mopani district) and Mutale (Vhembe District) reported not to have any assistance from any private organizations offering extension services.

6.6 Frequently requested climate forecasting

Figure 6.3indicates seasonal forecasts (69%) were the most requested types of forecasts in both districts. Vhembe district (37%) accounted for the highest consumption of seasonal forecasts in comparison of Mopani District (32%). According to Mpandeli (2014), the rainfall distribution patterns in the Vhembe district vary from location to location, smallholder farmers in the district use seasonal climate forecasting to inform various coping and climate adaptation strategies. Climate forecasting informs a range of farming business decision to changes in farming practices better suited for semi- arid conditions overwhelmed by climatic variability and poor rainfall

distribution that make agricultural productivity tough. Githungo et al. (undated) supports that Kenyan farmers recognized seasonal forecasts to be the most valuable type of climate information, which gave early warning and anticipation of poor crop seasons. This result show that farmers in the study area seek seasonal forecasts that are more localized, accurate and reliable than indigenous weather/climate forecasting methods that have become increasingly unreliable, due to climate variability.

Weather forecast (30%) accounted for the second most frequently requested type of forecast. Mopani district accounts for 18% of the result compared to 12% Vhembe District. This could be attributed to Mopani District having one prevalent farming enterprise over another (subsistence, smallholder), in comparison to Vhembe, which was observed to have a larger mix of farming enterprises (subsistence, smallholder, emerging and commercial farmers) requiring different climate forecasting to suit farmers' forecasting needs. Long- Term Forecast (2%) is the least used form of forecast disseminated to in both districts, Vhembe district is the only district where (2%) farmers asked about long- term climate forecasts.

Farmers requested weather forecasts and seasonal climate forecasts the most. Weather forecast (daily to weekly) and seasonal forecasts have been directly linked to planning farming activities such as crop diversification, land preparation, irrigation, insecticide, pesticides and fertilizer application and also prepare for unfortunate weather or poor crop seasons on a socio -economic level to some extent, buffering farmers form climate vulnerability.

Manjula and Rengalakshmi (2015) noted that smallholder farmers in India, who rely on rain-fed agriculture, accessed reliable climate forecasts in conjunction with short and medium range weather forecasts to support adaptive risk reduction measures. Roudier et al. (2014), add that climate forecasts have shown to have a positive impact in improving the resilience of African agriculture to climate shocks.

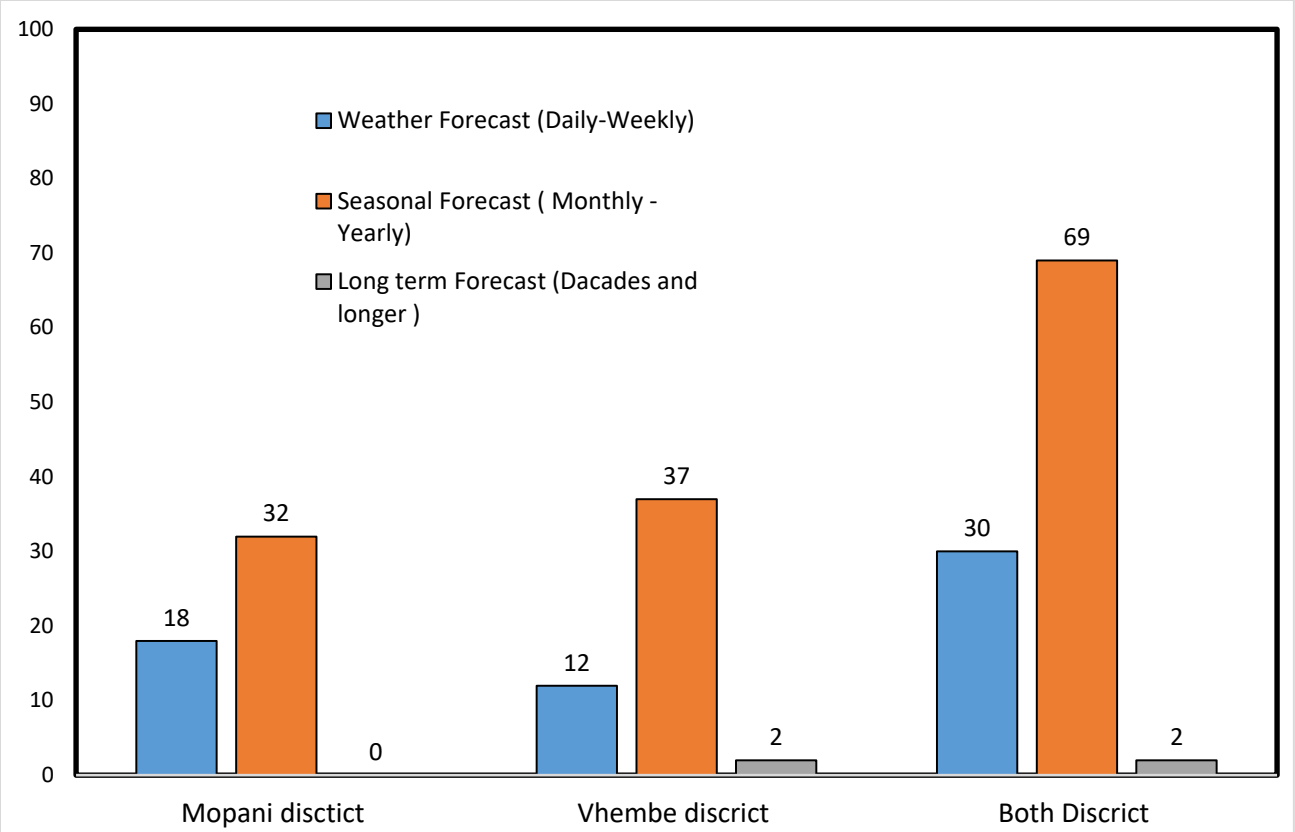

Figure 6.3: Climate forecast frequently requested by farmer from extension officers

6.7 Types of communication used to disseminate agricultural information to farmers

Personal Communication

Table 6.3 indicates that face-face communication (57.8%) was the most primary method used by AEOs. There were statistically significant differences in communication methods used to disseminated information across educational levels of AEOs (p=0.014). AEOs with a diploma or a B. Tech/degree qualification were more prone to use face-face communication. Whereas, AEOs with a postgraduate qualification were less prone to use face-face communication to disseminate information. According to extension officers communicating agricultural extension services, especially climate change information easier to explain. As it allowed AEOs to sense whether the farmer understood, allowed an opportunity for conversation with farmers and an opportunity to clarify any misunderstanding or queries immediately.

This is consistent to finding by several authors stating that several aspects of face-to-face communication is more salient and effective (Wolf and Moser 2011; Dryzek et al. 2011). Dryzek

et al. (2011), specifically argues that face- face communication it is more in person. Secondly, non-verbal cues such as body language allow the communicator to gauge how information is received at that time and responses come accordingly; direct communication also allows dialogue to emerge, and finally it fosters trust between conversing individuals, which goes a long way towards engaging and convincing someone. However, Bello and Obinne (2012), argued that interpersonal channel of communications have the disadvantage of being costly in terms of staff requirements, time and extension service coverage in comparison with other forms of communication. In addition, the quality of interpersonal channels was perceived to be low due messages communicated through them becoming greatly distorted as they flow along interpersonal chains.

Table 6.3: Techniques AEOs used to disseminate climate information to farmers

Variables		Education levels			Total (%)	Significance level
		Diploma (%)	B. Tech/Degree (%)	Postgraduate (%)		
Face-face communication	Yes	73.3	70.6	41.9	57.8	0.014
	No	26.7	29.4	58.1	42.2	
Workshops	Yes	65.1	70.0	70.6	53.3	0.004
	No	34.9	30.0	29.4	46.7	
Information days	Yes	16.7	18.6	76.5	28.9	0.001
	No	83.3	81.4	23.5	71.1	
Cell phone Communication	Yes	13.3	30.2	41.2	26.7	0.089
	No	86.7	69.8	58.8	73.3	
n		30	43	17	90	

Workshop

Workshops (53.3%) were the second most dominate channels to communicate climate information. There was a statistically significant difference in the use of workshops to disseminate agricultural information across education levels of AEOs (p=0.014). AEOs with a postgraduate or B. Tech/degree qualification were more inclined to use workshops to disseminate agricultural information. Whereas, AEOs with either a diploma or B. Tech/degree qualifications were less likely to use workshops to disseminate agricultural information.

However, AEOs i from the Mopani District said “poor coordination” between other government departments that negatively affects the quality of information presented at workshops, as official from the relevant departments are seldom available. A key informant from Musina (the Vhembe

district) stated, that have to improvise or completely cancel segments of the workshops, due to government officials not availing themselves at the workshops.

AEOs in Mutale added that the attendance records of workshops have seen a steady decrease from farmers, especially amongst female farmers. Findings by Donnelly et al. (2009) suggest that farmers are less likely to undertake adaptation methods or practices that require them to leave their land. Meinzen-Dick et al. (2011), stated that female farmers would attend workshops, demonstrations and training courses if they were held in their villages between certain periods of the day to accommodate household responsibilities.

Information Days

Information Days (28.9%) were the second least utilized means of information dissemination. There were statistically significant differences in the use of information day to disseminate agricultural information across education levels of AEOs (p=0.001). AEOs with a postgraduate qualification were more disposed to use information days to disseminate agricultural information. Whereas, AEOs with either a diploma or B. Tech/degree qualification were less liable to use information days to disseminate agricultural information.

This is consistent with findings by Baloyi (2010), who found that although information days were one of the agricultural services provided by extension officers in Limpopo. However, AEOs stated that organizing information days is quite challenging when coordinating with other organizations and departments, as they often have their own constraints (staff, time and transport shortages). AEOs in Musina stated their experience was different, as they have assistance from Timbali Technology Incubators; hence organizing information days is easier.

Cell phone Communication

Cell phone communication (26.7%) was least popular means of agricultural information dissemination. Results also show a statistically significant difference in the use of cell phone communication in the dissemination of agricultural information, between the education levels of AEOs (p=0.089). AEOs ' with a postgraduate qualification were more inclined to use cell phone communication to disseminate agricultural information. On the other hand, AEOs with a diploma or B. Tech/degree qualifications were less prone to use cell phone communication. Several authors have noted that cell phones as ICT were the most effective, popular and low-cost way to deliver

agricultural information, especially on climate change to smallholder farmers in Sub-Saharan Africa (Davis 2008; Asenso-Okyere and Mekonnon 2012; Omotesho et al. 2012). In contrast, AEOs cited cell phone tariffs, to be too expensive, especially during the day, which for them deters the use of voice calls. Furthermore, AEOs stated that Short Message Services (SMSs) were not effective as the majority of smallholder farmers were illiterate and/ or elderly and have difficulties in operating a cell phone.

6.8 Correct Use of Climate Information by Farmers

AEOs were asked their opinion on whether their farmers used agricultural information, especially on climate correctly. Table 6.7 below indicates a statistically significant difference in the correct use of climate change information by farmers between AEOs (p=0.006). AEOs from the Vhembe district were more confident in their ability to use climate change information correctly. In contrast, AEOs from the Mopani district reported their farmers used climate information incorrectly.

The incorrect use of climate information could be attributed to factors such a prolonged results from sustainable farming practices, as farmers would much rather use environmentally unsustainable agricultural inputs and practices that produce high yields in short time frames, then adapt sound agricultural practices that have slower results. This is in line with findings by Singh et al. (2015), who stated that farmers do not adopt practices, i.e. that incorporation of organic matter as they lack immediate results. The author suggested that there is a need for suitable mechanisms and incentives, that motivate would the adoption of climate -smart agriculture practices amongst farmers.

Table 6.4: Farmers use of climate change information correctly as perceived by AEOs

Variable	District		Total (%)	Significance level
	Mopani (%)	Vhembe (%)		
Yes	15.6	31.1	46.7	0.006
No	34.4	18.9	53.3	
n	45	45	90	

AEOs in the Mopani district stated, that the majority of their farmers regardless of age still had a tendency to adhere towards traditional African religion and practices, often a barrier to farmers

using agricultural information prescribed by LDARD. The AEOs stated that one popular explanations farmers give for the occurrence climate change is “The ancestors are punishing us for turning our backs on traditions or cultural rituals”. This is attributed to the belief that ancestors have a direct and indirect impact on the ability to influence nature especially climate variability though rain-making.

This idea is supported by Christian (2014), who stated that indigenous people in African countries affected by adverse climatic condition, i.e. prolonged drought (Kenya, Ethiopia and Somalia) and heavy floods (Nigeria), believe that believe “the gods are angry” and/or pray to their gods to remedy their environmental misfortunes. However Christian (2014), states that farmers are not completely ignorant of the causes of climate change. The causes are regarded as man-made disasters (sickness. death and adverse climate variability) are seen and understood to happen as a result of mankind’s’ bad behaviour. There are also farmers who understand climate change and its implication on their livelihoods, but cannot afford agricultural inputs such as climate resilient seeds, drip pipes for irrigation and environmentally friendly cultivators’ pesticides and herbicides (Afful et al., 2015).

6.9 Gender dynamic in climate information dissemination

The results show that the majority (53.3%) of extension officers observed gender differences in the use of climate change information amongst female and male farmers. There was a statistically significant difference in the views on use of climate change information by female and male farmers between AEOs in the study area ($p=0.003$). AEOs from the Vhembe were more prone to report that male and female farmers used climate change information differently. Whereas, AEOs from Mopani were less prone to report any differences in the use of climate information amongst male and female farmers, in areas they serviced. This is in line with findings by Adela and Ayoale (2012), who found that the majority (66.7%) extension agents agreed that the information needs of female farmers are somewhat different for men and 9.5% disagreed with the statement.

Focus group discussions revealed that female farmers in addition to the general agricultural information request additional for information on improving nutrition and household food security. Additionally, women were more likely to use organic farming practices such as manure, inter-cropped with indigenous leafy vegetables and were observed to diversify the crop variety. Male

farmers asked for climate information and technologies that improved yields and produced cash crops such as maize, tomatoes, and cabbages.

Table 6.5: Gender differences in climate information perceived by AEOs

Variable	District		Total (%)	Significance level
	Mopani (%)	Vhembe (%)		
Yes	37.8	68.9	53.3	0.003
No	62.2	31.1	46.7	
n	45	45	90	

Extension officers stated, that men were more likely to register for new programs, adopt new technologies and climate resilient seeds than women. Silvestri and Schubert (2015), supports that men and women farmers in West and East Africa tend to pursue different livelihood portfolios, i.e. what is grown and produced on the farm; women were less likely to grow high-value crops than men. Female farmers had a less diversified crop portfolio in contrast to what extension officers in the study area had reported.

6.10 Perception on suitability of climate change information by extension services

A Likert scale using variables such as “Strongly Agree”, “Agree”, “Disagree” and “Strongly Disagree”, were used assess whether extension officers observed current climate information to be compatible and appropriate to climate adaptation and mitigation needs of farmers. Table 6.9 indicated that observation were statistically significant differences between female and male extension officers in their perception on the suitability of climate change information disseminated to farmers (p=0.007). Female extension officers were more inclined to be “disagree” with the suitability of climate change information disseminated of farmers than men. Men were more likely to either 'strongly disagree' or 'agree' with the suitability of climate information disseminated to farmers’ needs.

AEOs revealed that they felt that the technologies prescribed by LDARD were not compatible with the resource levels of farmers; the majority could not afford Agricultural inputs such as climate resilient seeds, environmentally friendly cultivators and fertilizers, more so in female-headed households. The traditional extension approach, especially characterized Transfer of Technology (ToT) dispenses developed and tested agricultural products (technologies, inputs, and

knowledge) straight from science to the farmer. This widely used extension method prescribes farmers a passive role in their development, technologies are not developed with the end user in mind and are often not suitable to the farmer's environmental and socio-economic situation (Gonsalves 2005; Akinnagbe and Ajayi 2010; Akpalu 2013).

Table 6.6: Climate change information disseminated is suitable for farmers' needs

Variables	Gender of participants		Total (%)	Significance Level
	Females (%)	Males (%)		
Agree	7.1	11.1	18.9	0.007
Disagree	57.8	44.4	51.1	
Strongly Disagree	35.1	44.4	30.0	
n	28	62	90	

AEOs also indicated that the linear communication approach in public extension makes it very difficult for them to voice the views and needs of farmers; as they are seen as subordinates and mere technicians. This is unfortunate, as AEOs through their field experiences and perceptions could contribute in improving information flow and linkages between themselves, farmers and research, to produce solutions what would directly improve farmers' adaptation strategies and food security. AEOs also stated that they have observed that the majority of their superiors do not hold the relevant qualifications in the field of agriculture extension or work experience in agricultural extension services at the grass roots level. This in the experience of extension officers meant supervisors and managers did not fully grasp the role of agricultural extension advisory services, which has led to the misalignment of programs, projects and policies.

The agricultural extension policies have not yet found a way to integrate Indigenous Knowledge System (IKS) and cultural beliefs. Therefore, rural farmers, especially the elderly, are sceptical and less likely to adopt long-term climate adoption programs, project and programs. Altieri and Koohafkan (2008), suggests that traditional/indigenous farming systems are recognized worldwide as an effective measure in successfully driving rural climate change. Bonye et al. (2012), states that farmer's indigenous knowledge in extension service delivery is still by-passed; relevant support resources are not linked to or supportive of grass roots efforts. Anaeto et al. (2012), argue that though IKS integration in agricultural extension is a new paradigm, being aware of and

harnessing it would have a positive impact on rural agricultural development through improving the relevance of information dissemination to farmers.

6.11 Summary

The findings indicate that formal (traditional) extension is still the most dominate approached, used to diffuse agricultural information the majority of smallholder farmers serviced in the study area. However, formal extension was integrated with participatory extension approaches such as farmer-to-farmer, farmer-led and farmer field extension. Literature suggests that there is no one extension method or approach that can address the challenges climate change presents to rural farming communities. Therefore, it important to integrated a various approaches that better the varying extension needs of farmers.

Climate information regarding extreme weather occurrences, water management and climate forecast were the most disseminated types of climate information disseminated by extension officers. However, farmers were more likely to request weather–seasonal types of climate forecasting as they were more likely to have an impact on day-to-day farming activities such as irrigation, pest spraying, sowing and harvesting. Extension officers primarily used personal communication to disseminate agricultural and climate information, which was unexpected as rural extension services in Africa are moving towards this type of Information Communication technologies credited for increasing extension coverage and farmer contact.

Lastly, extension officers observed gender dynamics. Men and women used climate change according to their farming profile: men for high value crops for market purposes and women for more diverse crop variation used for household food security and nutrition. Despite these factors extension officers' perceived government–led agricultural climate information to be unsuitable for smallholder farmers. They attributed this to the costly needs of environmentally friendly agricultural inputs and climate resilient seeds, misaligned agricultural policies and blanket recommendations that are major hindrances to effectively delivering best-fit agricultural practices and climate resilient extension services.

CHAPTER 7: SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The study intended to contribute to the body of knowledge about gaps on climate change information in Agricultural Extension Advisory Service (AEAS). The study, conducted in the Limpopo province, focused on the AEAS personnel/extension officers from the Limpopo Department of Agriculture and Rural Development (LDARD). The first objective was to determine the extent of awareness of climate change and level understanding of extension officers about climate change in AEAS. The second objective was to assess the curriculum and further training offered to Agricultural Extension Officers (AEOs) received and its appropriateness in addressing the needs of smallholder farmers in the face of climate change.

The last objective was to establish the perceptions of extension services regarding the suitability of climate information disseminated to farmers in the study area. In order to accomplish the objectives, the study made use of literature review on climate change and adaptation at global level, on the African continent, and in South Africa to determine the effects of climate change on the agricultural sector. Literature about climate adaptation, resilience and coping strategies were discussed in relation to smallholder farmers' extension needs. The contribution of AEAS to rural development was discussed. Approaches to AEAS and current extension trends in Africa were also discussed.

The literature revealed that the rapid nature of climate change has had an unfavourable impact on AEASs' ability to provide effective extension services to rural farmers. Chapter 3 discussed the methodology used to conduct the study, which included the purposive sampling technique. Semi structured interview question for the key informants and focused group discussions were used to collect qualitative data. A questionnaire with open-ended questions collected quantitative data. The quantitative data was analysed using IBM SPSS 23 and discussed. This final chapter discusses major findings in the form of a summary, conclusion and recommendations.

7.2 Summary

The results of this research can be summarized according to Agricultural Extension Officer ss awareness and level of climate change knowledge, the curriculum and further training on climate

information received by AEOs, and the suitability of climate change information disseminated to smallholder farmers as perceived by extension officers.

Agricultural extension officers' perception of climate change

In Chapter 4 climate change awareness was categorized into (1) current climatic conditions, (2) temperature changes, (3) drought conditions, (4) crop failure and disease, (5) livestock disease and death, and (6) incidences of hunger. The different perceptions about these climate change impacts in the study area indicated that there were statistically significant differences in the climate awareness between male and female AEOs. Women were more likely to observe changes in temperature, crop failure and diseases as well as incidences of hunger. Men seemed more likely to perceive changes livestock disease and death, rainfall patterns and drought severity. However, overall AEOs perceived climatic conditions to be 'Bad': unreliable rainfall with little to poor agricultural yields, less pasture for livestock, high temperatures drying rivers, food insecurity, persistent droughts, unfavourable climate and increase in human disease/illness.

The majority of AEOs in the area had 'average' knowledge on climate change. However, more women were prone to report that their knowledge 'good'. This was in comparison to male AEOs who perceived their knowledge to be either 'average' or 'below average'. AEOs reported to have accessed climate change information mainly through the internet followed by the radio, television, newspaper and lastly social media outside the workplace. Female and male AEOs s had different sources of climate information. Female AEOs were more likely to use modern media such as the internet, social media and television. On the other hand, male AEOs used more traditional channels to access climate information such as radio and newspapers. Overall the study revealed that AEOs are, to some extent, knowledgeable about climate change, they also observed climatic conditions to be characterised by unreliable rainfall with little to poor agricultural yields, less pasture for livestock, high temperatures, drying rivers, increased food insecurity, persistent droughts, and increases in human disease.

Chapter 5 revealed that a high proportion of AEOs in the study area, had not received formal climate training in their curricula at the tertiary education level. This also suggest that there is a climate information gap in Agricultural Extension Training institutions. This challenge has been characterized by the slow integration and mainstreaming of climate change education into the current curricula taught to potential extension officers throughout the years. Extension officers

with higher levels of education were more likely to have been exposed to climate change education than those with lower levels of education. Additionally, the majority of extension officers reported not to have received in-service training from their employer, the LDARD. However, from the few AEOs who received in-service training, there was a statistically significant difference in the provision of capacity building training between educational levels. AEOs with lower levels of education were more likely to receive in-service training, in comparison to their counterparts with higher education levels. This was also seen to be consistent with National Departments Agriculture (NDA) policy that acts as a guideline when the recruitment of extension personnel in South Africa.

LDARD was also found to provide climate training to extension officers, however extension officers with less than or equal to five years' work experience were less likely to receive climate training. AEOs with six or greater than twenty years were more likely to get climate change training. AEOs received climate information from LDARD related to 'average temperature patterns', 'rainfall patterns', 'extreme weather patterns' 'crop and livestock pest and disease management'. This information was disseminated primarily through the provincial government email, the government intra-web, meetings, workshops and conferences. Despite, dissemination through these Information technology Communication (ICT) channels extension officers located in rural service centres reported that they did not receive climate information regularly. Overall AEOs' ' competency levels in disseminating climate change information was 'average'. AEOs with lower educations were less confident in their competency in disseminating climate information levels to their farmers, in comparison to their colleagues with higher education levels.

The suitability and appropriateness of climate information disseminated to farmer

Chapter 6 revealed that the main agricultural enterprise serviced by AEOs in the study is predominately rural smallholder–subsistence farming. They were characterized as resource poor, middle aged–elderly occupying marginal and illiterate often unemployed or seasonally employed. Agriculture was said to be their primary and sometimes only source of livelihood. In the study the traditional extension approaches characterized by Transfer of Technology (ToT) and Training and Visiting (T&V) approaches were dominate in disseminating agricultural and climate information. It was found that AEOs incorporated participatory approaches such as farmer to farmer, farmer field schools and farmer-led extension. These participatory approaches more farmer-centric, in comparison to traditional or formal extension. This also highlighted that no single extension

approach that is able to address the extension and climate information needs of rural farmers. The findings suggest that government-led extension services in South Africa apply multiple extension approaches to successfully implement climate resilient agricultural practices for sustainable food security. Additionally, it reflects the reform of public extension moving away from rigid Traditional supply-driven extension model to more demand-driven extension models.

Climate information such as 'extreme weather alerts', 'water management', 'crop management', 'climate forecasts' and 'livestock management' is disseminated to farmers. Multiple communication were used by AEOs to diffuse the above-mentioned climate information to farmers. Face-to-face communication was the most dominate channel of communication used to diffuse climate information. Whereas, mobile communication was the least dominate channel of communication. Education levels to some extent had an influence on the types of channels of communication used. AEOs with higher levels of education were more likely to use information days, workshops. While extension officers with lower levels of educations were prone to use face-face communication and mobile communication.

AEOs also felt that their farmers did not use the climate information they disseminated correctly. Agricultural inputs and practices prescribed by agricultural policies such as climate resilient seeds, drip pipe materials, organic cultivators drip and pesticides were too expensive for resource poor smallholder farmers. In addition, the majority of practices were unfamiliar to farmers and lacked did not incorporation of local indigenous knowledge systems. The study also revealed that male and female farmers serviced in the study areas had different farming profiles. Female farmers produced diverse crops variations mainly for household consumption; conversely, men produced high value crops mainly for market consumption. The majority of extension officers in the study area 'disagree' with the suitability and appropriateness of the climate information they disseminated to farmer.

7.3 Conclusion

The findings from this study concluded there is a climate information gap in AEAS more so in rural areas. Agricultural Extension Officers were ill equipped in addressing climate issues faced by farmers. The agricultural information was inappropriate to meet the extension needs of smallholder farmers, especially information regarding climate change.

Climate change effects have introduced new challenges in the agricultural has sector. These challenges create a demand for agricultural extension officers who are well equipped with knowledge and skills relevant to deal with climate change. More so, improved agriculture especially of smallholder farmers can only be realised if the AEOs' offer better services. In order for AEOs to meet the demands posed to farmers by climate change, there is a need to transform and reform extension models.

Better linkages between stakeholders in extension need to be forged as this interaction has the opportunity to promote dialogue on, which initiative have or have not been successful in building climate resilience amongst rural farmers. It is understandable that climate change is a new challenge requiring agricultural institutions and AEAS to adjust accordingly. It should the responsibility of agricultural institutions, primarily university and Agricultural Extension Training (AET) to build extension capacity, with climate education at the tertiary education level. Extension officers cannot be expected to empower farmers unless they are empowered themselves.

Capacity building of AEOs needs to be carried into AEAS through frequent training of extension officers in new agricultural information, extension approaches and to reorient farmers to national agricultural goals. This will also ensure that extension officers have clearly understanding of their responsibilities and roles, in facilitating climate resilience. In addition, it is extremely important for AEAS stakeholders not to overlook the contribution local indigenous knowledge system. They are an integral tool that will increase the acceptability, cost-effectiveness and the suitability of AEAS prescribed to farmers.

The strengths, weakness, opportunities and threats possessed by public AEAS in the study in relation to the climate information gap were identified.

Strengths

- In- depth understanding of local farmers' perception and extension needs.
- Extension officers have long-standing relationships with farmers in the areas.
- The majority of extension officers have long-term work experience in the field.
- Extension officers have grass root coverage of rural communities.
- Extension officers have basic knowledge about climate change.

- ❖ Extension officers in the study have improved qualification levels in comparison to extension officers in Sub Saharan Africa (SSA).

Weakness

- ❖ Poor Linkages between research, extension officers and farmers resulting in poor information flow
- ❖ Government-led extension is still rooted in the 'Top-down'/linear approach.
- ❖ Poor rural service centre infrastructure
- ❖ Limited access to Information Communications Technologies (I.C.T's)
- ❖ Scarce resources due to insignificant budget allocation and constraints
- ❖ Lack of local indigenous knowledge systems (I.K.S) in climate change adaptation and mitigation strategies prescribed to farmers.
- ❖ Poor policy formation and implication that weakens rural farmer's climate resilient and threatens their livelihoods.
- ❖ Low literacy levels of farmers

Opportunities

- ❖ The availability of an in-house meteorology component at LDARD providing weather information services.
- ❖ A favourable extension officer to farmer ratio
- ❖ The incorporation of participatory approaches in the diffusion of agricultural information
- ❖ Linkages to private organizations and NGOs in providing extension services alongside with public extension services. In addition, the private stakeholder providing climate change related training to public extension officers.
- ❖ Improved household food security through the dissemination of climate information
- ❖ The inclusion of climate change education at Agricultural Extension Training (AET) institutions.

Threats

- The rapidly changing nature of climate change, AEAS are slow in keeping up
- The slow integration and main-streaming of climate education into agricultural fields
- Poor provision of in-service training, retraining and frequent training of extension officers.
- The widespread use of traditional extension approaches
- Lack of technology and localized information for extension officers, such as accurate weather forecasts.
- Poor monitoring and evaluation of policies, projects and programs aimed at climate adaptation and resilience of resource poor farmer.

7.4 Recommendations

Recommendations for improving the impact of Agricultural Extension Advisory Services (AEAS) to bridge the climate information gap in government -led extension are as follows:

- LDARD should improve and increase agricultural education and training of all extension officers. LDARD must re skill extension officers frequently due to the changing nature of agricultural sector and climate change to fill the knowledge gap.
- AEAS should be better funded, to improve rural service centre infrastructure, internet connectivity, relieve transport constraints and increase the opportunities to receive in-service training and climate change training consistently.
- Integration of local indigenous knowledge systems in climate adaptation and mitigation strategies, programs and project. This would increase the acceptability of AEAS to rural the rural farmer. They would be more likely to embrace familiar adaptation and mitigation strategies that are in line with the local farmers' traditions and beliefs.
- When developing climate adaptation and mitigation strategies, rural farmers and extension officers, should be involved in planning, monitoring, evaluation and problem solving. As this will ensure local indigenous knowledge, dissemination

preferences and grass roots challenges are considered, reducing policy/project misalignment.

- Probabilistic climate forecasting, particularly weather and seasonal forecast are often unreliable and liable to error. LDARD has the capacity to provide more localized and precise climate forecasting information. This would increase the reliability of climate forecast in each locale of the province and also increase the confidence of farmers in AEAS.

7.5 Limitations of the study

The service centres are situated far apart from one another, which made it difficult to reach all the Agricultural Extension Officers (AEOs) before they went out into the field. Some AEOswere on leave consequently decreasing the expected sample size of the study. In order to generalize the results from the study, a larger sample size is needed. More provinces should be included in the study. Secondly, a test should be administered on extension officers to measure their scientific or theoretical knowledge on climate.

7.6 Area of further study

The extent of indigenous knowledge systems integration in government-led extension should be in coping with the effects of climate change in rural agrarian communities.

Investigating the extent to which farmers participant in agricultural extension education and training programs

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APPENDIX A: QUESTIONNAIRE

Questionnaire

Meeting the Needs of Smallholder Farmers: The climate information gap within Extension and Advisory Services

African Center of Food Security- UKZN

NB: All *the information provided here will be treated as STRICTLY CONFIDENTIAL.*

DATE: …….

NAME OF INTEVIEWER: ……

DISTRICT MUNICIPALITY (please tick the appropriate box):

Mopani	Vhembe

LOCAL MUNICIPALITIES (please tick the appropriate box):

Tzaneen	Maruleng	Musina	Mutale

Section A: Characteristics (please tick the appropriate box):

1.1. Gender

1. Female	2. Male

1.2. Age

1. ≤30yrs	2. 31- 59 yrs.	3. >60 yrs.

1.3. Employment status

1. Full Time	2. Part- time	3. Volunteer

3.1. Level of Qualification

1. Degree	2. Diploma	3. Certificate	4. Higher Certificate

1.5. Does the qualification you hold specialize in? (If 'Other' please specify):

1. Agricultural Extension ☐ 2. Agricultural Science ☐

3. Crop production ☐ 4. Livestock Production ☐

5. Other ☐

Please Specify ……..

1.6. Number of year of Experience in Extension Advisory Services

1. ≥5	2. 6-15	3. 16-20	4. ≥20

Section B: Extension Officers Perception of Climate Change/variability

a. Your current perception of current climatic conditions?

1. Good ☐ 2. Bad ☐ 3.Poor ☐ 4. Constant ☐

2.2 Temperatures in your municipality/ area of work over the last 5-10yrs:

1.Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4.Uncertain ☐

2.3. Severity of drought in your municipality:

1. Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4. Uncertain ☐

2.4. Incidence of crop failure experienced by farmers

1. Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4. Uncertain ☐

2.5. Incidences of crop diseases

1. Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4. Unsure

2.6. Incidences of livestock diseases

1. Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4. Unsure

2.7. Incidences of hunger reported/experienced by farmers?

1. Increased ☐ 2. Constant ☐ 3. Decreased ☐ 4. Unsure ☐

2.8 How are you exposed to climate change information, other than the workplace?

1. Newspapers ☐ 2. Television ☐

3. Radio ☐ 4. Internet ☐

5. Social Media ☐ 6. Other ☐

2.9 current understanding /knowledge on climate change is:

1. Excellent	2. Good	3. Average	4. Poor

Section C: Extension officer's pre- training (Curriculum) and In-service training.

3.1. Climate change was taught in the curriculum of your qualification?
(If 'Yes' please specify):

1. Yes 2. No

……....

……

3.2. Have you received any in-service training from LDA covering climate change? **(If 'yes', briefly explain)**

1. Yes 2. No

……

……

3.4. Does the Limpopo Department provide you with climate information and training?

1. Yes ☐ 2.No ☐

3.5. How often are provided climate information by LDARD? (**If 'none of the above' please specify).**

1. Weekly ☐ 2. Monthly 3.Quarterly ☐

3. Yearly ☐ 4. None of the above ☐

……

……

3.5.1. If you receive information, what form is the Information disseminated to you? (If 'other' please specify)

1. Workshops, Conferences and Meetings ☐ 2. Pamphlets/ Booklets ☐

3. C.D's ☐ 4. Training manuals ☐

5. Government Email ☐ 6. Provincial Government Websites ☐

6. Radio ☐ 7. Other ☐

Please Specify

……..……..

3.6. What climate information is covered? **(Please List below)**

……

3.7. Your competency level in disseminating this information given by LDARD to farmers is:

1. Excellent	2. Good	3. Average	4. Neutral	5.Poor

Section D: Suitability of Climate Information Disseminated as Perceived by Extension Officers.

4.1 What is the main agricultural enterprise of the farmers you work with?

Subsistence farming ☐ 2. Small-scale Farming ☐

3. Emerging small-scale farming ☐ 4. Commercial Farming ☐

4.2. What types of extension service do you offer farmers? **(Please tick the appropriate box**

1. Formal Extension	2. Farmer Field School	3. Farmer – Farmer Extension	4 Farmer –Led Extension	5. Not Sure	7. Other

If other, Specify below

……

4.3. Is climate information disseminated regularly to farmers? (**If 'No', briefly explain why).**

1. Yes ☐ 2. NO ☐

……

……

4.4. What types of climate information do you offer to farmers for climate change impacts/effect? **(Please list below).**

……

……

4.5. How is climate information disseminated/ communicated to farmers? (Tick as many that apply)

1. Mobile communication ☐ 3. Internet ☐

2. Radio ☐ 4. Workshops ☐

5. Face – to Face communication ☐ 6. Information days ☐

7. Other ☐

Please Specify ……

4.5 Which types of forecasting do farmers frequently ask for?

1= High Frequency 2 = Frequency 3= low Frequency

1.Weather forecasts (Days to weeks)	2. Seasonal climate Forecasts (months to years)	3 Long-range climate Forecasts (Decades to longer)

4.6 Do you find Men and Women ask for different climate information?

1. Yes ☐ 2. No ☐

4.7. Farmers are using the climate change information correctly.

1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree

4.8 Do you think the climate information you provide is suitable for the climate change/variability impacts smallholder/small-scale farmers' face.

1.Strongly Disagree	2 Disagree		3 Neutral	4 Agree	5Strongly Agree

APPENDIX B: SEMI-STRUCTURED INTERVIEW GUIDE LINE

SEMI-STRUCTURED AND FOCUS GROUP INTERVIEW GUIDE FOR KEY INFORMANTS

Pre-Interview.

1. Welcome interviewee

2. Explain that this interview will be recorded, their anonymity will be maintained, ask for their permission and then Switch on recording device **(very important**).

3. Notify participants that the interview will take 10 -20 minutes and focus group discussions 30 -45 minutes.

4 Explain the purpose of this interview and the long term benefits it may have.

Interview and focus group discussions.

Q.1. Do you find that extension officers have a practical understanding of climate change?

Q.2. Where do you/they find climate information from?

Q.3. what role do you think extension services has in climate change resilience for farmers?

Q.4. In your perspective is climate information and training received helpful in disseminating climate information to farmers at: 1. Training institutions, 2.In-service training, 3. LDARD climate training

Q.5. What types of training does LDARD offer concerning climate change?

Q.6. What are the core competencies does an extension officer need, especially when diffusing climate information?

Q.7. What are the types of climate information disseminated to farmers?

Q.8. As AEAS, what are the main challenges faced by extension officers regarding the curriculum and further training?

Q.9. What are some of the capacity gaps do you feel AEAS needs to fill?

Q. 10. What are some of the delivery gaps do you feel AEAS needs fill?

Now thank the participant/s for their time (very important), switch off recording device